Conformed

BOEING

[redacted]

SEATTLE, WASHINGTON

Operating Instructions Only

INSTRUCTION MANUAL

INTERFERENCE ANALYZER

EMC-25 SERIES

BC 556330

OFFICIAL RECORDS STATION
FILE COPY
FACILITIES
MAR 5 1970

FAIRCHILD
ELECTRO-METRICS
CORPORATION
A SUBSIDIARY OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

AMSTERDAM, NEW YORK

ERRATA

The EMC-25 Series Instruction Manual, as issued March 31, 1969 should be corrected as follows:

Page 3-5, Section 3.8: Item C: Omit, "C. EXY-125A."

Page 3-5, Section 3.8: Change Item d), to read as follows:

"d) To operate the EXY-125A in conjunction with the EMC-25, both 34 pin connectors of the CJB-25 must be used; one with any of the items in c) above and the other to the EXY-125A through cable XYC-25A."

Page 3-5, Section 3.8: Add Item 3), as follows:

"e) Simultaneous use of both 34 pin connectors of the CJB-25, for other than EXY-125A usage, is reserved for special applications."

Page 3-7, Section 3.11.4: Change last sentence to read as follows:

"Similarly, Quasi-Peak measurements made with the EMC-25 probably will not agree at all levels with those made on a measuring set with vacuum tube circuitry."

Schematic voltages are in red and all underlined voltages are DC measured with respect to chassis ground with an 11 megohm voltmeter, tolerance is ±10%.

ADDENDUM

NOTE

This addendum is applicable only to EMC-25 incorporating the RN modification.

All EMC-25RN equipment incorporate the following modifications:

A. Figure 6.11, Discriminator (A8) Schematic Diagram

1. 8.7 MHz IF band --
   a. Input capacitor C-2 is deleted.
   b. Damping resistor R-1 is changed from 220 ohms to 1K ohms.
   c. Emitter resistor R-2 is changed from 470 ohms to 680 ohms.
   d. Resistor R-8 is deleted.

2. 1.6 MHz IF band --
   a. Input damping resistor is deleted.
   b. Change resistor R-8 from 12K ohms to 27K ohms.

3. 175kHz IF band --
   a. Input resistor R-1 is deleted.
   b. A 680pfd capacitor is added across Input Secondary T-2001.

B. Figure 6.12 Video Detector (A1A1) Schematic Diagram:

1. Transistor Q22 is changed from FT57 to 2N4416.
2. A 220 ohm resistor is added between the source and ground of transistor Q22.
3. Resistor R53 is replaced with a short circuit.
4. + end of 2.2mfd capacitor C18 is changed from the drain to the source of transistor Q22.
5. An FT600 diode is inserted between capacitor C18 and resistor R50 with cathode on R50 side. (See item 7 below.)
6. A 150K ohm resistor is inserted between junction of FT600 diode (see item 5 above) and capacitor C18 and drain of transistor Q18.
7. Change resistor R50 from 1K ohms to 2.2K ohms.

C. Figure 6.13 Control Section (A1A6) Schematic Diagram

1. Sweep tune board --
   a. A jumper is placed between pin 10 and pin 20 on sweep tune board socket (pin 10 is used only on that equipment that incorporates the RN modification)

2. Audio board --
   a. Wire from output of PC board to phone jack and remote plug is removed and is replaced between the shielded wire ground on shielded wire connect to the ground lug on the audio board holder.

3. Front panel module --
   a. Audio control (volume)
      1) Two FD600 diodes in series with ground leg of the volume control (A1R1) are added.

      2) A 10K ohm resistor in series with the + (potentiometer) leg of the volume control (A1R1) is added (normal, but not shown on schematic).

4. Tuning potentiometer --

   a. A .15mfd capacitor is added between arm and ground of the tuning potentiometer.

ADDENDUM II N OPTION

Operation Instructions

Normal operation is unchanged except that an ultra narrow bandwidth is added and may be operated simply by changing the BANDWIDTH switch on the front panel to the 0.1 NB position.

Because of the extremely narrow bandwidths of the 0.1 NB position on the BANDWIDTH selector, a dual FINE TUNE control is used on the EMC-25N. The outer black ring, the normal FINE TUNE, is used with WB and NB positions and the inner grey knob, a vernier, is used in conjunction with the normal FINE TUNE for the ultra narrow bandwidth.

With the BANDWIDTH switch in the 0.1 NB position the approximate 3 dB bandwidths of the normal EMC-25N are as follows:

Bands 1-7 (14 kHz - 2.3 MHz) is 50 Hz

Bands 8-10 (2.3 MHz - 25 MHz) is 500 Hz

Bands 11-15 (25 MHz - 1 GHz) is 5 kHz

Operating the EMC-25N in the 0.1 NB mode improves CW tangential sensitivities approximately 10 dB more than the NB mode.

N Version EMC-25 Alignment:

Following are additional alignment instructions for N Version EMC-25s. This procedure does not include the adjustment of the narrowband filter unit.

AFC Adjustments: (Each IF Frequency)

1. Connect a sensitive D.C. coupled oscilloscope to the AFC output terminal of the Video Detector (feed thru capacitor C22 on the right-hand rear side of Video Detector).

2. Set bandwidth switch to WIDE, AFC switch to OFF, ATTENUATOR in CAL, Tuning to MAN, Tuning Mode OFF, Detector Function to CARR.

3. Feed in a full scale CW signal from a signal generator. Slowly sweep the frequency of the generator back and forth across the frequency to which the receiver is tuned, noting the symmetry of the discriminator output on the scope.

4. Adjust the Discriminator transformers T__002 and T__003 so that the peak positive and peak negative output voltage swings are symmetrical about the noise line, and also so that, when the signal generator voltage is adjusted for maximum meter deflection, the discriminator output voltage as indicated on the scope is the same as the mean noise base line viewed when the input signal frequency is far from the resonant frequency to which the receiver is tuned.

5. Now turn the bandwidth switch to .1 NB. With no signal tuned in, adjust the sensitivity and positioning of the scope so that noise of 2 to 3 cm is presented in the center position of the screen.

6. Adjust the discriminator input transformer T__001 for a minimum noise level, and for symmetry in the noise wave shape about the base line.

7. Now very slowly vary the signal generator back and forth across the resonant frequency to which the receiver is tuned. Make slight adjustments to discriminator coil T__003 so that the small portion of the discriminator curve which is now present (because of the .1 NB filter) is symmetrically centered around the mean noise level.

8. Now turn the AFC switch to "ON". Carefully tune and fine-tune the receiver until it has acquired the signal, and it is adjusted for maximum amplitude. Now remove the input signal momentarily, (disconnect the input), then reconnect it and note if the signal is recaptured. If not, a careful trial and error adjustment is required as follows:

a. Turn slug T__003 slightly clockwise. Then tune in the signal for maximum amplitude, disconnect and reconnect the input signal and note if signal is captured.

b. If the signal is not recaptured, but seems closer to the recapture point, turn slug T__003 slightly more clockwise, retune for maximum, once more disconnect and reconnect the signal, and note if the signal is recaptured.

c. If the clockwise adjustments seem to be moving the signal further from the recapture point (more fine-tuning required to retune the signal), repeat the above procedures, turning discriminator transformer slug T__003 in a counterclockwise direction.

d. Continue the trial and error adjustment until the signal is recaptured.

e. Since this adjustment depends on the receivers noise level, and since this noise level and character varies from band to band, and for different frequency settings on one band, recapture may not be possible for all tuning control settings on all bands. Since the top band in each IF frequency range (Bands 7, 10, and 15) will be the most critical in tuning, these bands should be used for the discriminator adjustment. The tuning control should be about center band frequency. A slight compromise of adjustment may be required to obtain recapture pull-in over the greatest frequency range.

Sweep-Tune Board Adjustment: (A1P1-2)

1. The control which formally was used to set the low end tuning voltage (R3, right-hand side of band) is now to be adjusted for 0.00V at the low voltage tune output (terminal #11 of A5TB1), with the FREQUENCY control fully counterclockwise against the mechanical stop.

2. Sweep Limit Control. This is a Trimit type 275 Pot (R13) located in the approximate center of the sweep-tune board. It controls the upper tuning voltage limit when the receiver is in Sweep position, and initiates the sweep return and pen lift functions (when using X-Y plotter). It is adjusted as follows:

Monitor the low tuning voltage (terminal #11 of A5TB1) with the FREQUENCY control fully clockwise against the mechanical stop. (Receiver in manual tuning). If the voltage is low (about .1V), adjust the sweep limit pot (R13) counterclockwise until the voltage jumps up. (It should suddenly jump to about 1.5V). Next adjust the high frequency control (R1 on left-hand side of the Sweep-Tune Board) until the output voltage is 1.500V. Now turn the sweep limit pot (R13) clockwise until the tuning voltage suddenly drops low, then slowly turn this control counterclockwise until the voltage once more jumps up to 1.5V.

High End and Low End Frequency Adjustments:

The High End Frequency is adjusted in the normal manner. The High Frequency Control is R1 located on the left-hand side of the Sweep-Tune Board as before.

The Low End Frequency adjustment (R36) is now located on the Tuning Regulator Board (rear wall of EMC-25). It is the only control on this board, and the low frequency adjustment is made as before, using this control. In N version models, the battery must be removed, (but kept electrically connected) to reach this adjustment.

Tuning Aid Adjustment:

In N Version models the final BFO frequency adjustment for each IF frequency must be made with the crystal filter installed in the system and the bandwidth switch in .1 NB position. An RF CW signal is fed into the input or an IF CW signal may be fed into the IF strip. The signal is carefully tuned in for maximum indication on the meter, and the BFO frequency adjustment (L__004) on the log detector is adjusted for a zero beat in the earphones. (If the BFO frequency is greatly misadjusted the initial BFO adjustment may be made in wideband).

TABLE OF CONTENTS

Paragraph		Page
SECTION I - INTRODUCTION		1-1
1.1	THE MANUAL	1-1
1.2	THE EMC-25	1-1
1.3	ELECTRICAL SPECIFICATIONS	1-1
1.3.1	Frequency Range	1-1
1.3.2	Frequency Accuracy	1-1
1.3.3	Input Impedance	1-1
1.3.4	Voltage Accuracy	1-1
1.3.5	Sensitivity and Bandwidth	1-1
1.3.6	Spurious Rejection	1-1
1.3.7	Voltage Range	1-1
1.3.8	Frequency Control	1-1
1.3.9	Detector Functions	1-2
1.3.10	Outputs	1-2
1.3.11	Calibration	1-2
1.3.12	Power Requirements	1-2
SECTION II - THEORY OF OPERATION		2-1
2.1	INTRODUCTION	2-1
2.2	MECHANICAL CONSTRUCTION	2-1
2.2.1	General	2-1
2.2.2	Main Compartment	2-1
2.2.3	Power Supply	2-1
2.2.4	Control Section	2-1

Paragraph Page

2.3 POWER SUPPLY 2-1

2.3.1 General 2-1

2.3.2 Battery Charger and Crowbar Circuits (A5P2) 2-2

2.3.3 Low Voltage Regulator and Battery Test Circuit (A5P3) 2-2

2.3.4 High Voltage Converter (A5A1) 2-3

2.3.5 Tuning Regulator (A5P4) 2-3

2.4 ATTENUATORS AND RF TUNER 2-3

2.4.1 Attenuators 2-3

2.4.2 RF Tuner 2-4

2.4.3 Bands 1-9 2-4

2.4.4 Local Oscillator AGC 2-7

2.4.5 Band 10 Operation 2-7

2.4.6 Band 11 Operation 2-7

2.4.7 Band 12 Operation 2-8

2.4.8 Band 13 Operation 2-8

2.4.9 Band 14 Operation 2-9

2.4.10 Band 15 Operation 2-9

2.5 PRE AMPLIFIER (A2A2) 2-10

2.6 IF AMPLIFIER (A3) 2-11

2.6 N OPTION (Crystal Filter A10) 2-12

2.6.1 General 2-12

2.6.2 Control Parameters 2-12

2.6.3 Remote Operation 2-12

2.7 DETECTION SYSTEM 2-12

Paragraph Page

2.7.1 General 2-12
2.7.2 Log Detector (A4) 2-12
2.7.3 Video Detector (A1A1) 2-14
2.7.3.1 Video Detector (A1A1-1) 2-14
2.7.3.2 Video Detector (A1A1-2) 2-15
2.7.4 Discriminator (A8) 2-15

2.8 CONTROL SECTION (A1) 2-16

2.8.1 Calibrator (A1A2) 2-16
2.8.2 Sweep Tune (A1P1) 2-16
2.8.3 Audio Amplifier (A1P2) 2-16
2.8.4 External Control 2-17

2.9 R OPTION (A9) 2-17

2.10 ACCESSORIES 2-17

2.10.1 General 2-17
2.10.2 Programming Accessories 2-17
2.10.3 Pick-Up Devices 2-17
2.10.4 Convenience Accessories 2-18

SECTION III - OPERATION INSTRUCTIONS 3-1

3.1 GENERAL 3-1

3.2 UNPACKING 3-1

3.3 ELECTRONIC SHIPPING DAMAGE 3-1

3.4 POWER REQUIREMENTS 3-1

3.5 BATTERY POWER SUPPLY 3-1

Paragraph Page

3.6 INSTALLATION 3-2

3.7 PRE-OPERATIONAL CALIBRATIONS 3-2

3.7.2 CW Calibration 3-2

3.7.3 Broadband Calibration 3-5

3.7.4 Large Signal Operation 3-5

3.8 ACCESSORY CONNECTIONS 3-5

3.9 OPERATION PRECAUTIONS 3-5

3.9.1 Dummy Plug 3-5

3.9.2 Input Voltage 3-5

3.9.3 Off Frequency Signals 3-5

3.9.4 Audio Output 3-5

3.9.5 Tuning Accuracy 3-5

3.9.6 Amplitude Accuracy 3-5

3.10 CONTROL FUNCTIONS 3-6

3.10.1 Attenuator 3-6

3.10.2 Tuning 3-6

3.10.3 Fine Tuning 3-6

3.10.4 Tuning Mode 3-6

3.10.5 Sweep Start 3-6

3.10.6 Tuning Aid 3-7

3.10.7 Shunt Cal 3-7

3.10.8 Series Cal 3-7

3.10.9 Detector Function 3-7

3.10.10 Dump 3-7

3.10.11 Threshold 3-7

Paragraph Page

3.10.12 Audio 3-7
3.10.13 Bandswitch 3-7
3.10.14 Bandwidth 3-7
3.10.15 Cal. 3-7
3.10.16 Power 3-7

3.11 DETECTOR FUNCTIONS 3-7

3.11.1 General 3-7
3.11.2 Slideback 3-7
3.11.3 Carrier 3-7
3.11.4 Quasi-Peak 3-7
3.11.5 Peak 3-7
3.11.6 AM Modulation 3-8
3.11.7 FM Modulation 3-8

3.12 AFC OPERATION 3-8

3.13 TUNING AID OPERATION 3-8

3.14 BANDWIDTH CONTROL 3-8

3.15 CONNECTOR FUNCTIONS - FRONT PANEL 3-8

3.15.1 RF Input 3-8
3.15.2 IG Output 3-8
3.15.3 Phones 3-8
3.15.4 AM Video 3-8
3.15.5 FM Video 3-9
3.15.6 Remote Connector 3-9

3.16 CONNECTOR FUNCTIONS - REAR PANEL 3-9

Paragraph Page

3.16.1 Pre-IF Output 3-9
3.16.2 Post-IF Output 3-9
3.16.3 Power Input 3-9

3.17 BATTERY OPERATION 3-9

3.17.1 Charging the Battery 3-9

3.18 LINE OPERATION 3-10

3.19 EXTERNAL BATTERY 3-10

3.20 REMOTE OPERATION 3-11

3.20.1 Programing 3-11

3.21 X-Y PLOTTING 3-11

3.21.1 General 3-11
3.21.2 Internal Sweep 3-11

SECTION IV - PERFORMANCE CHECK-OUT 4-1

4.1 GENERAL 4-1

4.2 WHEN TO TEST 4-1

4.3 PERFORMANCE TESTING PROCEDURE 4-1

4.4 ACCURACY AND PERFORMANCE TESTS 4-1

4.4.1 Precautions 4-1
4.4.2 CW Voltage Accuracy 4-1
4.4.3 Broadband Voltage Accuracy 4-2
4.4.4 Frequency Accuracy 4-3

Paragraph Page

4.4.5 Attenuator Accuracy 4-3
4.4.6 CW Sensitivity 4-3
4.4.7 Impulse Sensitivity 4-3
4.4.8 Bandwidth 4-3
4.4.9 Meter Tracking and Dynamic Range 4-3
4.4.10 Image Rejection 4-4
4.4.11 IF Rejection 4-4
4.4.12 Spurious Response 4-4
4.4.13 Sweep 4-4

SECTION V - MAINTENANCE AND REPAIR 5-1

5.1 GENERAL 5-1

5.2 MAINTENANCE 5-1

5.3 CALIBRATION 5-1

5.3.1 Calibration Charts 5-1
5.3.2 Making Calibration Charts 5-1
5.3.3 Calibration Chart Procedure 5-1

5.4 REPAIR 5-2

5.4.1 Repair Procedures 5-2
5.4.2 Repair Sequence Guide 5-3
5.4.3 Common Faults 5-3
5.4.4 Power Supply Checking 5-4
5.4.5 IF and Detection System Checking 5-4
5.4.6 Calibraor - RF Tuner Checking 5-12
5.4.7 Band Segments 5-14

Figure | Page

Figure 3.1 Interference Analyzer (Inverted), Installation Drawing 3-2

Figure 3.2 Typical Calibration Chart - Broad and Narrow Band 3-3

Figure 3.3 Control Settings for Calibration 3-4

Figure 3.4 EMC-25 Front Panel Connectors and Controls 3-6

Figure 3.5 Connector Functions, Rear Panel 3-9

Figure 3.6 Remote Connector (Outside View) 3-10

Figure 3.7 Remote Connector (Manual Operation) 3-11

Figure 3.8 X-Y Plotter - Remote Connections 3-12

Figure 3.9 Audio - Remote Connections 3-12

Figure 3.10 Tuning - Remote Connections 3-13

Figure 3.11 Gain - Remote Connections 3-13

Figure 3.12 Tuning Meter - Remote Connections 3-13

Figure 3.13 External Meter/Plotter - Remote Connections 3-14

Figure 3.14 Bandwidth - Remote Connections 3-14

Figure 3.15 Manual Tune - External Sweep - Remote Connections 3-14

Figure 5.1 Broadband Factors 5-2

Figure 5.2 Repair Sequence Guide 5-3

Figure 5.3 Location Guide (Bottom View) 5-5

Figure 5.4 Power Supply Checking 5-7

Figure 5.5 IF and Detection System Checking 5-8

Figure 5.6 Calibrator and RF Tuner Checking 5-13

Figure 5.7 Dial Stringing (sequence figures: a, b, c, d, e and f) ..... 5-15 to 5-17

Figure 6.1 Schematic Location Guide 6-2

Figure 6.2 RF Tuner (A2), Schematic Diagram 6-3

Figure 6.3 Band 1-9 (A2A1, 1-9), Schematic Diagram 6-4

Figure 6.4 Preamp (A2A2), Schematic Diagram 6-5

Figure 6.5 Band 10 (A2A1, 10), Schematic Diagram 6-6

Figure 6.6 Band 11 (A2A1, 11). Schematic Diagram 6-7

Figure | Page

Figure 6.7 Band 12 (A2A1, 12), Schematic Diagram 6-8

Figure 6.8a Band 13 (A2A1, 13), Schematic Diagram 6-9a

Figure 6.8b Band 14 (A2A1, 14), Schematic Diagram 6-9b

Figure 6.8c Band 15-1 (A2A1, 15-1), Schematic Diagram 6-9c

Figure 6.8d Band 15-2 (A2A1, 15-2), Schematic Diagram 6-9d

Figure 6.9 IF Amplifier (A3), Schematic Diagram 6-10

Figure 6.10 Log Detector (A4), Schematic Diagram 6-11

Figure 6.11 Discriminator (A8), Schematic Diagram 6-12

Figure 6.12 Video Detector (A1A1), Schematic Diagram 6-13

Figure 6.13 Control Section (A1A6), Schematic Diagram 6-14

Figure 6.14 Audio Circuit (A1P2), Schematic Diagram 6-15

Figure 6.15 Sweep Circuit (A1P1), Schematic Diagram 6-15

Figure 6.16 Power Supply (A5), Schematic Diagram 6-16

Figure 6.17 Low Voltage Regulator (A5P3), Schematic Diagram 6-17

Figure 6.18 Tuning Regulator (A5P4), Schematic Diagram 6-17

Figure 6.19 R Option (A9-2), Schematic Diagram 6-18

Figure 6.20 N Option Filter, Schematic Diagram 6-18a

Figure 6.21 Inter-Wiring Diagram, Filter Option 6-18b

SECTION I
INTRODUCTION

1.1 THE MANUAL

This manual includes all relevant information for the successful operation, maintenance and repair of Interference Analyzer EMC-25 or 25R indicated by the serial numbers on the manual's title page. It will be assumed unless specifically noted, that this manual applies to all versions.

1.2 THE EMC-25

Fairchild Electro-Metrics' Interference Analyzer Model EMC-25 has been designed to fill the growing need for instrumentation for RFI/EMC measurements starting with high audio frequencies up to the UHF range.

EMC-25 Interference Analyzer is designed for use as the major component of interference analysis systems for the 14 KHz to 1 GHz range. The instrument itself is a programmable selective RF voltmeter, compatible with a wide variety of peripheral equipment. A selection of antennas enables the measurement of radiated electric and magnetic field intensity, while various output devices simplify data reduction and extend the EMC-25's usefulness as a system component.

It is used as an RFI/EMC meter, a field strength meter, a frequency-selective 2-terminal voltmeter, and other applications requiring a highly sensitive, shielded receiving instrument.

Frequency tuning, band selection (with "R" option), AFC on-off, internal sweep voltage, impulse generator operation and level, bandwidth selection, detector dump operation, and vernier gain can all be externally programmed. Outputs are provided for the pre-IF and post-IF, DC-coupled AM and FM video, audio, voltage analog of frequency, voltage analog of amplitude, binary band indication, center channel tuning indication, and for the impulse generator.

Instructions for operating accessory equipment are supplied with each accessory. Specific applications are discussed in separate application notes. Field intensities are determined by the simple addition of the calibration factors supplied in the instruction manual for the respective antenna being employed.

1.3 ELECTRICAL SPECIFICATIONS

1.3.1 FREQUENCY RANGE. The usable frequency range extends from 14 KHz to 1 GHz in 15 bands.

Each band provides a minimum of 2% overlap at each end with respect to adjacent bands.

1.3.2 FREQUENCY ACCURACY. Frequency accuracy is within plus or minus two percent of indicated frequency. (With FINE TUNE control at mid-rotation.)

1.3.3 INPUT IMPEDANCE. Input impedance is a nominal 50 ohms.

1.3.4 VOLTAGE ACCURACY. Two-terminal CW voltage measurements, referenced against the internal calibrator, are accurate within plus or minus 1.5 DB (top 20 DB of the scale).

1.3.5 SENSITIVITY AND BANDWIDTH. Table 1-1 shows the sensitivity and bandwidth of the EMC-25 Interference Analyzer.

1.3.6 SPURIOUS REJECTION. Rejection to Image and IF, and other spurious frequencies typically exceeds 60 DB and is never worse than 45 DB throughout the entire 14 KHz to 1000 MHz range.

1.3.7 VOLTAGE RANGE. The analyzer is capable of measuring signals as large as 1.0 V RMS. Voltage ranges are obtained by means of a 20 DB per step attenuator. Overall front panel meter range is 60 DB. Front-end attenuation is inserted in all positions except the most sensitive.

1.3.8 FREQUENCY CONTROL. The analyzer is tunable over any single band by means of a front panel control or by the application of a suitable voltage to a front panel connector.

Frequency bands are switched by a single front panel control or optionally by means of a remotely controllable internal stepping motor. The remote band indication is accomplished by means of binary switch closures.

TABLE 1-1

SENSITIVITY AND BANDWIDTH

BAND	FREQUENCY RANGE	BW (3 DB) NB (Nominal Bandwidths)	BW (3 DB) WB (Nominal Bandwidths)	SENSITIVITY (worst case) *CW (NB) (uV)	SENSITIVITY (worst case) *(IMPULSE (WB) (DB/uV/MHz)
1	14.0 KHz-28.5 KHz	500 Hz	4 KHz	0.06	+39
2	28.5 KHz-59.0 KHz	500 Hz	4 KHz	0.06	+39
3	59.0 KHz-120 KHz	500 Hz	4 KHz	0.06	+39
4	120 KHz-240 KHz	500 Hz	4 KHz	0.06	+39
5	240 KHz-480 KHz	500 Hz	4 KHz	0.06	+39
6	.48 MHz-1.05 MHz	500 Hz	5 KHz	0.06	+39
7	1.05 MHz-2.30 MHz	500 Hz	5 KHz	0.06	+38
8	2.30 MHz-5.00 MHz	5 KHz	50 KHz	0.12	+22
9	5.00 MHz-11.0 MHz	5 KHz	50 KHz	0.12	+22
10	11.0 MHz-25 MHz	5 KHz	50 KHz	0.12	+22
11	24 MHz-49 MHz	50 KHz	500 KHz	0.80	+20
12	49 MHz-98 MHz	50 KHz	500 KHz	0.80	+20
13	98 MHz-210 MHz	50 KHz	500 KHz	0.80	+23
14	210 MHz-490 MHz	50 KHz	500 KHz	1.00	+24
15	490 MHz-1000 MHz	50 KHz	500 KHz	1.60	+32

*NOTE: Tangential Sensitivity -- defined as the internal noise level or as the input signal level required to raise the meter reading 3 DB above the instrument noise. Tangential Sensitivity level is at least 8 DB above minimum discernible signal (MDS). MDS is sometimes defined as being 0.5 DB above the noise level.

1.3.9 DETECTOR FUNCTIONS

1.3.9.1 CARRIER. Responding to the RMS value of an unmodulated sine wave and having nominal 600 milliseconds charge and discharge times.

1.3.9.2 QUASI-PEAK. As in CARRIER except nominal charge time is 1 millisecond and discharge time 600 milliseconds.

1.3.9.3 PEAK. As in CARRIER except charge time is $<< 1/BW$ and discharge time is sufficiently long to read an impulse of 10 PPS rep rate with less that 1 DB decrease in accuracy.

1.3.9.4 SLIDEBACK. A metered indication of the detector biasing required for aural extinction of signals.

1.3.10 OUTPUTS

1.3.10.1 POST-IF: 1.0 MV RMS nominal into 50 ohms.

1.3.10.2 PRE-IF: 50 uV RMS nominal into 50 ohms.

1.3.10.3 VIDEO: 25 MV PEAK nominal into 91 ohms.

1.3.10.4 AUDIO: 100 MW nominal into 600 ohms.

1.3.10.5 RECORDER, external meter: 1 MA at 1500 ohms.

1.3.10.6 X-Y PLOTTING: Y-axis 0 to +1.5 VDC into 1.5K ohms $\pm$ 1%. X-axis 0 to +1.4 VDC nominal into greater than 10 K ohms.

1.3.11 CALIBRATION. The instrument includes a built-in wideband calibration system.

1.3.12 POWER REQUIREMENTS. The analyzer operates from 105 V to 130 V, or 210 V to 260 V, 50-450 CPS, as well as from its own internal battery supply, or from an external DC source.

Switching between internal supply and external supply is automatic when connected to external supply.

The EMC-25 is supplied with AC power cord, instruction manual, alignment tools and certificate of performance, DC power cord, battery pack, instrument carrying case, carrying cover with handle, adapter brackets, earphones, and control junction box.

SECTION II
THEORY OF OPERATION

2.0 THEORY OF OPERATION

2.1 INTRODUCTION

Interference Analyzer Model EMC-25 is an accurately calibrated, highly shielded, superheterodyne receiver. Most parameters are remotely programmable through either voltage application, resistance change or contact closure to the front panel REMOTE connector, as well as manually controllable. Reference to the signal flow diagram Figure 2.1 and schematic diagrams at the rear of the manual will aid in understanding EMC-25 operation.

2.2 MECHANICAL CONSTRUCTION

2.2.1 GENERAL

The EMC-25 is divided into three major compartments, the main compartment, the power supply and the control section. The instrument is of unit construction with the main box constructed of dip-brazed aluminum. Interior assemblies are fastened to the bulkhead, front and rear panels by means of machine screws and by quarter turn fasteners to permanently welded fixtures.

2.2.2 MAIN COMPARTMENT

This compartment is completely shielded and houses all RF and IF frequency amplifying circuits. Most of the sub-assemblies located in the main compartment are constructed on printed circuit boards within aluminum castings with sheet metal covers. The only two shafts, (the IF Attenuator and the manual bandswitching controls) protruding into this compartment are made of fiber glass and pass through waveguide below cut-off bushings. All control leads to this compartment are filtered by either the filter affixed to the bulkhead or the power supply filter located on the power supply assembly. The bottom cover of the instrument is retained by 40 screws which surround this compartment and compress a metal impregnated plastic gasket to complete the shielding.

2.2.3 POWER SUPPLY

The power supply assembly is entirely located on, and within, an aluminum casting and is secured to the rear wall of the instrument by 24 screws that also compress a woven RFI gasket between the rear wall and the casting. On the main compartment side of the supply is a bracket mount that supports the plug-in circuit board of the tuning regulator and the low voltage regulator. The encapsulated power supply filter mounted atop this assembly also acts as a heat sink for the regulator transistors of the low voltage power supply and as a support for a pair of barrier strips that distribute power supply voltages and control signals to all components in this compartment.

The chassis located inside the casting serves as a mounting for the constant current battery charger and the high voltage converter. Therefore these components are well shielded from the inside of the instrument. The power supply chassis assembly is removable from the rear panel by loosening two quarter turn fasteners.

2.2.4 CONTROL SECTION

The compartment directly behind the front panel contains all the control and interfacing circuits for local and remote control. These circuits are relatively non-susceptible to RFI and consequently need very little shielding from the external environment. However, filtering is provided for all control and power leads that pass into the main compartment by a filter mounted on the bulkhead between the control and main compartment sections. Within the control section mounted to the bulkhead is a video detector that processes video information and applies it to the front panel meter. The calibrator, the RF attenuator and the input low pass filter, all mounted behind the front panel are interconnected with coaxial cable having a solid outer conductor which further contributes to shielding effectiveness. Behind the front panel meter; a metal bracket mounts the audio amplifier and the sweep tune plug-in circuit boards. The manual tuning potentiometer is also located on the front panel on a cast assembly which carries the tuning dial cursor.

2.3 POWER SUPPLY

2.3.1 GENERAL

To permit field operation and to reduce the possibility of ground loops in laboratory work, a nickel-cadmium battery is used for the primary power supply. The battery additionally serves the useful purpose of

a pre-regulator for AC line operation. In the battery charger compartment are located a constant current supply for charging the battery and a high voltage converter. High impedance of those power lines entering the main circuit section facilitates a high degree of filtering. The low voltage series-regulated power supply and the tuning voltage regulator follow closely conventional practice.

2.3.2 BATTERY CHARGER AND CROWBAR CIRCUITS (A5P2)

The EMC-25 battery consists of 24 four-ampere-hour cells in series, 15 on the positive side and 9 on the negative side. Integral with the battery package are 2 two-ampere thermal self-resetting circuit breakers, one in the positive leg and one in the negative leg of the battery. The battery is connected by means of a three-prong connector and short cable to A5TB1A, the central distribution point for all power in the instrument. The metal battery case is secured to the instrument by means of four quarter-turn fasteners.

A nominal 400 milliampere constant current charging circuit for the battery is located on circuit card A5P2, the Current Regulator, inside the power supply casting. On this card diodes CR1 thru CR8 rectify the 50 volts AC supplied by transformer A5T1. The nominal 47 volts DC across C1 is then applied to the constant current regulator consisting of CR5, a 5.6 volt reference diode, A5Q1, the regulator, and A5RT1A and A5RT1B which serve both as a constant current reference and as an indication that the charger circuit is supplying a constant current. A5RT1A and B are both 6 volt lamps whose total current adds up to the 400 milliampere supplied by the constant current circuit. Diode CR5 maintains a constant voltage between the positive terminal of the power supply and the base of A5Q1. The gain of this transistor is sufficiently high that a constant voltage is also maintained between its emitter and the positive supply. As A5RT1A and B are connected in this leg, a constant current is maintained through them and thus a constant current also flows through the collector of A5Q1. This constant current passes through CR7, CR9, filter A5FL1 and thus to the battery. CR7 and CR9 provide reverse voltage protection for the charging circuit and the crowbar circuit described below.

An external battery supply may also be used with the EMC-25. The positive leg of the external supply passes through pin E of A5J1, then S1, a one ampere thermal self-resetting circuit breaker, and then CR5, a reverse voltage protection diode, into the constant current charging circuit. Similarly, the negative side of the external supply passes through S2 and CR6. Thus the external supply must always be of a sufficiently higher voltage than the internal battery to operate the constant current charging circuit. Lamps A5RT1A and B will glow when the external source supplies a charging current to the internal battery.

If the EMC-25 battery is accidentally disconnected, or if one of its circuit breakers should open due to an overload and the constant current charging circuit is still in operation, an over-voltage might be applied to the A5FL1 filter and a number of other components within the EMC-25, causing considerable damage. To prevent this occurrence, two crowbar circuits are installed on the A5P2 current regulator board. The operation of these two circuits is identical. The positive crowbar circuit consists of CR10, CR12 and R2. The silicon controlled rectifier, CR10, is normally prevented from firing because its gate is returned to ground through R2. CR12 is a 27 volt breakdown diode. When the positive supply reaches a voltage greater than 27 volts, CR12 breaks down and conducts, causing current to flow into the CR10 gate circuit, firing CR10. The SCR then becomes a short circuit, remaining so until either the AC power supply or external battery supply is temporarily disconnected. The negative crowbar has a 16 volt breakdown point.

2.3.3 LOW VOLTAGE REGULATOR AND BATTERY TEST CIRCUIT (A5P3)

All amplifying circuits in the EMC-25 operate from +12 volt and -6 volt regulated power supplies, with the exception of the audio amplifier A1P2. The series regulator transistors, A5Q3 for the positive supply, and A5Q2 for the negative supply, are located on the power supply assembly adjacent to A5TB1. Amplifying and reference circuits for these supplies are located on A5J3, a plug-in card which is also attached to the power supply assembly. On A5J3, a precision reference diode, CR2, determines the stability of all power supplies within the EMC-25. Transistor Q6 senses the difference between the reference voltage and the output of the +12 supply as divided by R9 and R10. The amplified difference is applied to the base of Q2 which further amplifies the signal and applies it to an emitter follower, Q1, which then provides sufficient drive to operate series regulator A5Q3. A 9 volt breakdown diode, CR1, provides proper operating voltages for Q2 and Q3. The stability of the power supply is unaffected by CR1. Resistor R8, a factory selected component, provides positive feedback to the power supply to compensate for variations in battery voltage. The reference for the -6 volt power supply is the +12 volt power supply, therefore, the +12 volt supply must be operating properly in order for the -6 volt supply to do so. Amplifier Q7 senses the difference between ground and the divided output of the +12 volt and the -6 volt supply as determined by R14 and R15. This amplified difference is applied to Q3, which further amplifies and applies it to the emitter follower Q5 which then provides sufficient drive to A5Q2, the series regulator transistor for the -6 volt supply.

The characteristic of the nickel-cadmium cells used in the EMC-25 battery is such that a simple measurement of the voltage existing across the battery does not indicate whether there is sufficient voltage to properly operate the regulator circuits. To alleviate this problem a circuit is built into A5P3 which determines that the regulators are operating normally. If sufficient battery voltage exists to properly operate the regulator circuits, a red light on the panel will light as the BAT TEST pushbutton is depressed. This circuit operates as follows:

The anode-cathode circuit of CR3 is connected in series with the BAT TEST switch and light. Transistors Q8 and Q9 are in series with resistor R17 in the gate-cathode circuit of CR3. If both Q8 and Q9 are conducting, the battery light will light when the battery switch is depressed. If either Q8 or Q9 or both do not conduct, no voltage will be developed across R17, resulting in the absence of gate current to fire CR3. During normal operation of the regulator, Q8 is saturated by the collector current of Q6. When the battery voltage falls to a low enough level that the +12 volt regulator ceases to operate, the right hand section of Q6 will be cut off causing Q8 to cut off. In the -6 volt regulator, Q4 senses the current passed by Q3. When the negative side of the battery develops insufficient voltage to operate the negative regulator, Q3 will be cut off, resulting in the loss of base current for Q4 and subsequently turning off Q9.

2.3.4 HIGH VOLTAGE CONVERTER (A5A1)

To supply the regulated 84 volts required by the tuning regulator, a high voltage converter is located inside the power supply casting to convert the battery voltage to approximately 200 volts DC. This converter consists of a class C oscillator, Q1, operating at 200 kHz. The secondary coil of the oscillator transformer, T1, steps up the output of the oscillator to approximately 200 volts peak-to-peak. Rectifiers CR1 through CR4 rectify this voltage and C7, C8 and L2 filter it. The oscillator is operated at 200 kHz due to the ease of shielding and filtering at this frequency. Resistor R2 and capacitor C5 are factory selected components to compensate for variations in transistor Q1.

2.3.5 TUNING REGULATOR (A5P4)

All bandstrips of the EMC-25 are tuned by means of varactors. Due to the non-linear voltage-versus-capacitance characteristic of the varactors and non-linear capacitance-frequency relationship required for linear tuning, a non-linear regulating circuit is needed to supply this voltage in order to have a nearly linear tuning scale. This regulator is entirely located on the A5P4 Tuning Regulator card. In this circuit, Q1 senses the difference between the tuning voltage of 0 to +1.5 volts supplied to the left-hand base and the output of the high voltage regulator supplied through a voltage-variable divider network. The difference between the reference and the output of the divider network sensed by Q1 is amplified and applied to Q3 where it is further amplified and applied to Q4. Q4 again amplifies the signal and applies it to an emitter follower, Q5. Q5 is the series regulator transistor for the high voltage tuning regulator. Transistors Q2 and Q6 are used to improve the fall time of the regulator.

Breakdown diode CR1 prevents the collector of Q4 from rising above 110 volts, the nominal rating of the diode. By doing so, it prevents the output of the tuning regulator from rising above the breakdown voltage of the varactor tuning diodes. CR1 is selectively connected to either ground or the -6 volt supply to adjust for tolerance in its breakdown voltage.

The voltage variable divider network, used to obtain the warped output-vs-input voltage characteristic, provides 6 straight line segments that are an approximation of the desired curve. At extremely low output voltages, the divider consists of R6 and R8. However, at higher voltages, the divider consists of R6, and R8 in parallel with R9, R10, R11, R12, and R13. The output voltage, at which R9 thru R13 are inserted in the circuit, is determined by a precision voltage divider consisting of R15 thru R19 and R22. As the output voltage of the Tuning Regulator rises, diodes CR2 thru CR6 conduct sequentially, inserting their respective series resistors into the voltage divider network. Diodes CR7 and CR8 provide the same voltage drop vs. temperature characteristic as CR2 thru CR6, thus providing temperature stability for the voltage divider circuit.

2.4 ATTENUATORS AND RF TUNER

2.4.1 ATTENUATORS

A single control having 20dB increments is used to adjust the input signal level to the instrument. Both RF and IF attenuation is provided by this control. The first attenuator position avoids RF attenuation and thus provides maximum sensitivity of the instrument, whereas further attenuation steps add RF attenuation to improve the input impedance and prevent RF overload. Reduction of the noise displayed on the meter is accomplished by adding IF attenuation. Chart 2.1 lists the amount of attenuation used.

TABLE 2-1

RF & IF ATTENUATION

ATTENUATOR POSITION		ATTENUATION				
		RF		IF		TOTAL
BLACK	ORANGE	dB		dB		dB
0	20	0	+	0	=	0
20	40	6	+	14	=	20
40	60	16	+	24	=	40
60	80	36	+	24	=	60
80	100	56	+	24	=	80
100	---	76	+	24	=	100

2.4.2 RF TUNER

The function of the RF Tuner is to select and amplify RF signals, convert these signals to desired IF signal, and pre-amplify the IF signal.

The frequency range (14 kHz - 1 GHz) of the EMC-25 is covered in 15 bands. The band selection is accomplished by using 15 bandstrips mounted on a rotor in the RF Tuner.

For Bands 1-9, the only components on the Bandstrips are RF transformers, RF coils, buffer and padder capacitors, loading resistors, and coupling capacitors.

For Bands 10-15, part or all of the active RF circuitry is mounted on the bandstrip. This is done to minimize lead lengths and stray capacities at the higher frequencies.

In Bands 13-15, double conversion is used to improve image rejection. Table 2-2 shows the IF frequencies and LO frequencies for all bands.

A Stator Board is mounted adjacent to the rotor. This printed circuit board contains the components not included in the rotor to complete the circuitry required for tuning. Connections are made between the bandstrips on the rotor and the Stator Board by means of a set of thirty contacts.

2.4.3 BANDS 1-9

The operation of Bands 1-9 can be seen by following the signal flow through Band 7. Figure 6.2 RF Tuner (A2) schematic, is a schematic drawing of the Stator Board with Band 7 bandstrip in position. Figure 6.4 is the schematic for Bands 1-9.

The RF signal comes from the Calibrator Assembly (A1A2) through a semi-rigid coaxial cable. This coaxial cable is terminated at Pin 2 of the contact strip of the Stator Board. Pin 1 and Pin 3 are used as ground points for the coaxial cable. The signal passes through Pin 2 to the untuned primary of T0701 on the bandstrip. The untuned primary presents a nominal 50 ohm impedance at the frequency to which the receiver is tuned. T0701 is a voltage step up transformer with a tuned secondary. The secondary of T0701 is tuned by voltage variable capacitors which are mounted on the Stator Board and are connected to the secondary of T0701 through Pin 4 and Pin 6. The secondary of T0701 is also tuned by the buffer capacitor, C1, mounted on the bandstrip. C1 is a tracking adjustment used only in the initial setup of the band. Voltage variable capacitors CR1 and CR2 tune T0701 over the frequency range of the bandstrip. The tuning voltage for CR1 and CR2 is derived from the Tuning Regulator (A5P4).

The voltage variable capacitors mounted on the Stator Board, CR1, CR2, etc., are actually two voltage variable capacitors CR1A and CR1B connected in series. The series connection is required to prevent large RF signals from changing the DC bias voltage at low tuning voltages and thus detuning the circuit.

Bands 1-7 use CR1 and CR2 in parallel to obtain a higher capacitance for tuning. Bands 8 and 9 use only CR1 since a low capacitance is sufficient.

The gate of the field effect transistor, Q1, mounted on the Stator Board is connected to the secondary of T0701 through Pin 5. The gate of the field effect transistor is a high impedance. The function of T0701 is to transform this impedance to the 50 ohm input impedance and at the same time it is a tuned circuit which provides preselection. The diodes CR3 and CR4, that are connected to the gate of Q1 provide over-voltage protection.

The field effect transistor, Q1, and the bipolar transistor, Q2, are a cascode RF amplifier. Their function is to amplify the RF signal. The signal goes from the collector of Q2 to the double tuned circuit on the bandstrip used for preselection; selectivity of the double tuned circuit is higher than for a single tuned circuit.

Referring to Figure 6.2, the collector supply voltage for Q2 comes from Pin 10 thru R1 and L0702 on the bandstrip to Pin 8. Voltage variable capacitor CR5 is connected to L0702 thru Pin 9, and CR6 on the Stator Board is connected thru Pin 11. CR5 and CR6 are the main tuning for L0702 and derive their tuning voltage from the same place as CR1 and CR2. Buffer capacitor, C2, on the bandstrip is a tracking adjustment.

Voltage variable capacitor CR7 on the Stator Board is connected to L0703 through Pin 13. Voltage variable capacitor CR8 on the Stator Board is connected to L0703 through Pin 15. CR7 and CR8 are the main tuning for L0703 and derive their tuning voltage from the same point as CR1 and CR2. Buffer capacitor C4 is a tracking adjustment for L0703. C3 adjusts the coefficient of coupling between the two tuned

TABLE 2-2

INPUT IF AND LO FREQUENCIES

BAND	INPUT FREQ.	1st IF FREQ.	1st LO FREQ.	2nd IF FREQ.	2nd LO FREQ.
1	14-30 kHz	175 kHz	189-205 kHz		
2	28.5-61 kHz	175 kHz	203.5-236 kHz		
3	59-128 kHz	175 kHz	234-303 kHz		
4	120-260 kHz	1.6 MHz	1.72-1.86 MHz	175 kHz	1.425 MHz
5	240-520 kHz	175 kHz	415-695 MHz		
6	.48-1.10 MHz	175 kHz	.655-1.275 MHz		
7	1.05-2.4 MHz	175 kHz	1.180-2.575 MHz		
8	2.30-5.3 MHz	1.6 MHz	3.9-6.9 MHz		
9	5-11.4 MHz	1.6 MHz	6.6-13.0 MHz		
10	11-25 MHz	1.6 MHz	12.6-26.6 MHz		
11	24-51 MHz	8.7 MHz	32.7-59.7 MHz		
12	50-102 MHz	8.7 MHz	58.7-110.7 MHz		
13	100-215 MHz	38.7 MHz	138.7-253.7 MHz	8.7 MHz	30.0 MHz
14	210-500 MHz	68.7 MHz	278.7-568.7 MHz	8.7 MHz	60.0 MHz
15	490-1000 MHz	98.7 MHz	588.7-1098.7 MHz	8.7 MHz	90.0 MHz

circuits.

The RF signal output from the double tuned circuit comes from the voltage divider consisting of R3 and R2 on the bandstrip. C5 is a frequency compensating capacitor which helps keep the gain flat with respect to frequency. The RF signal output goes through Pin 16 to the gate of the field effect transistor Q3 on the Stator Board. Field effect transistor Q3 and transistor Q4 are a unity gain impedance convertor. Their function is to increase the impedance of Q5 so that the double tuned circuit is not loaded too heavily.

Transistors Q5 and Q6 on the Stator Board constitute a balanced mixer, which mixes the RF signal and the local oscillator signal to generate an IF signal. A balanced mixer is required in order to cancel any local oscillator signal at the output of the mixer, since at the low frequency end of Band 1, the local oscillator frequency is very close to IF frequency. Also at the upper end of Band 3, the RF Amplifier is tuned to a frequency very close to the IF frequency. In order to achieve good IF rejection on the upper end of Band 3, the IF signal at the output of the mixer must be cancelled.

Transistors Q5 and Q6 are matched for V_{BE} and H_{FE} so that their gain and mixing characteristics are nearly identical. The RF signal is injected from the source of Q3 to the emitter of Q5 and the base of Q6.

The RF signal is introduced at the emitter of Q5 and the base of Q6 and LO signal at the base of Q5 and the emitter of Q6. RF and LO signals introduced at the bases produce collector currents 180^{o} out of phase with the input signals. Signals applied to the emitters produce in-phase collector currents com-

ponents. As the collectors of Q5 and Q6 are connected together, the collector currents produced by RF signals will be out of phase and equal in amplitude, causing cancellation at this point. LO signals will be similarly cancelled.

The IF signals generated in the emitter base junction of Q5 and Q6 are identical, so IF signals at the collectors of Q5 and Q6 are additive. The transformer T2001 and capacitor C51 in the collector of Q5 and Q6 is a tuned circuit tuned to the 175 kHz, one of the IF frequencies. This tank circuit is connected to the collector of Q5 and Q6 through diode switch CR9. Bandstrips utilizing the 175 kHz IF have a jumper wire on the bandstrip connecting Pin 20, a +12V point, to Pin 17, this causes CR9 to conduct, which connects the 175 kHz IF signal. It then is taken from the secondary of T2001 and connected to TP2 on the Preamp Board through a coaxial cable.

The transformer T3001 and capacitor C52 in the collector of Q5 and Q6 is a tuned circuit tuned to 1.6 MHz. This tank is connected to the collector of Q5 and Q6 by the diode switch CR10. Bandstrips utilizing the 1.6 MHz IF have a jumper wire on the bandstrip, a +12V point, this causes CR10 to conduct which connects the 1.6 MHz tuned circuit to the collector Q6. The 1.6 MHz IF is taken from the secondary of T3001 and connected to TP3 on the Preamp board through a coaxial cable.

Refer to Table 2-2 for the IF frequency used with each bandstrip.

The local oscillator signal is generated by transistor Q11 on the Stator Board. The tuned circuit for the oscillator is on the bandstrip. The oscillator is a Hartley configuration. The primary of T0704 is the inductance for the tuned circuit and is connected to the collector of Q11. Feedback for the oscillator is taken from a tap on the primary coil and connected to the emitter of Q11. The primary coil is tuned to the emitter of Q11. The primary coil is tuned by voltage variable capacitors CR11, and CR12 on the Stator Board.

The local oscillator output is taken from the secondary of R0704, and passes to the gate of field effect transistor Q8. Transistor Q8 and transistor Q7 form a unity gain impedance convertor similar to Q3 and Q4. The local oscillator signal is coupled from the source of Q8 to the emitter of Q6 and the base of Q5, the mixer transistors.

a) Band 1 RF Amplifier

The RF signal goes from the calibrator assembly A1A2J2, through Pin2 on the Stator Board to the untuned primary of T0101 on the Band 1 bandstrip. The secondary of T0101 is a single tuned circuit. This circuit is tuned by voltage variable capacitors CR1 and CR2 on the Stator Board. The signal goes from the secondary to the gate of Q1 on the Stator Board. Q1 and Q2 form a cascode amplifier which amplifies the RF signal.

The collector of Q2 drives the under-coupled double-tuned circuit on the Band 1 bandstrip. L0102, on the bandstrip, in parallel with voltage variable capacitors, CR5 and CR6 on the Stator Board, constitutes the first tuned circuit of the double-tuned network. L0103, on the bandstrip, in parallel with voltage variable capacitors, CR7 and CR8 on the Stator Board, constitutes the second tuned circuit of the double-tuned network. The network is top coupled by the low pass filter consisting of R1, R2, and C4, on the bandstrip.

The output of the double-tuned network is taken from the voltage divider consisting of R3 and R4 which is across L0103.

b) Band 2, 3, and 4 RF Amplifier

The RF signal goes from the Calibrator Assembly A1A2J5, through Pin 2 on the Stator Board, to the untuned primary of T0201 on the Band 2 bandstrip.

NOTE

Band 2, 3, and 4 RF amplifier are similar. The description on Band 3 is the same as Band 2; just interchange T0301 for T0201, etc.

The secondary of T0201 is a single tuned circuit tuned by voltage variable capacitors, CR1 and CR2 on the Stator Board.

The RF signal goes from the secondary of T0201 to the gate of Q1 on the Stator Board. Q1 and Q2 are a cascode amplifier which amplifies the RF signal. The collector of Q2 drives the under-coupled double-tuned network on the bandstrip. The primary of T0202 in parallel with voltage variable capacitors CR5 and CR6, on the Stator Board, forms the first parallel resonant circuit of the double-tuned network. The second parallel tuned circuit is formed by the series combination of L0203 and the secondary of T0202 in parallel with voltage variable capacitors, CR7 and CR8 on the Stator Board. The double-tuned network is coupled by the secondary of T0202.

The output of the double-tuned network comes from the voltage divider across L0203 and the secondary of T0202.

c) Band 5, 6, 7, 8, and 9 RF Amplifier

The RF signal goes from the calibrator assembly A1A2J5, through Pin 2 on the Stator Board, to the untuned primary of T0501 on the Band 5 bandstrip.

NOTE

Bands 5, 6, 7, 8, and 9 RF amplifier are all similar. The description for Band 6, 7, 8, and 9 is the same as for Band 5, just interchange T0601 for T0501, etc.

The secondary of T0501 is tuned by voltage variable capacitors CR1 and CR2 on the Stator Board.

The RF signal goes from the secondary of T0501 to the gate of Q1 on the Stator Board. Q1 and Q2 are a cascode amplifier which amplifies the RF signal.

The collector of Q2 drives the under - coupled double-tuned network on the bandstrip. The coil L0502 on the bandstrip in parallel with voltage variable capacitors CR5 and CR6, on the Stator Board constitutes the first parallel tuned circuit.

The coil L0503 on the bandstrip in parallel with voltage variable capacitors CR7 and CR8 on the Stator Board constitutes the second parallel resonant circuit of the double - tuned network. The double-tuned network is bottom coupled. The coupling reactance consists of C4 on the bandstrip and the lead inductance to the ground return of voltage variable capacitors CR5, CR6, CR7, and CR8.

The output of the double - tuned network comes from the voltage divider R2 and R3 across L0503 on the bandstrip.

d) Band 1-9 Local Oscillator Operation

The Local Oscillator for Bands 1-9 are similar. The operation of the Local Oscillator can be seen by following the operation of the Band 1 LO. Q11, on the Stator Board is the oscillator transistor. The collector of Q11 drives the parallel tuned circuit consisting of the primary T0104, on the bandstrip and voltage variable capacitors CR11 and CR12 on the Stator Board. The feedback signal comes from the tap on the primary of T0104 and goes to the emitter of Q11. This oscillator is in a Hartley configuration. The output signal from the oscillator comes from the secondary of T0104.

2.4.4 LOCAL OSCILLATOR AGC

The Local Oscillator output in Bands 1-10 is kept at a constant amplitude by an AGC circuit operating in the following manner:

The base of transistor Q13-A samples the local oscillator signal at Pin 23. Q13-A and Q13-B are a differential amplifier. The local oscillator signal is detected by the emitter base junction of Q13-A. The detected signal is compared to the DC reference on the base of Q13-B. The difference signal is amplified by Q12 and Q10, and the output current of Q10, which is connected to the emitter of Q11, the local oscillator, is used to AGC Q11. The AGC action holds the amplitude of the local oscillator signal constant. The local oscillator level is adjusted by varying the DC reference voltage at the base of Q13-B. This is done by the OSC LEVEL control R52 on the Stator Board.

2.4.5 BAND 10 OPERATION

The operation of Band 10 is similar to Bands 1-9 except, due to lead length consideration, the whole RF amplifier is on the bandstrip. Referring to Figure 6.5, Band 10 Schematic Diagram, the RF signal passes through Pin 2 to the untuned primary of T1. T1 is a voltage step up transformer and the secondary is tuned by voltage variable capacitors CR1, CR2, CR3, and CR4 on the bandstrip. The secondary of T1 is connected to the gate of Q1. Field effect transistors Q1 and Q2 are the 1st RF amplifier. They are connected in a doublet configuration which utilizes the g_m of Q1 and the beta of Q2 for gain. The collector of Q2 drives a single tuned tank which consists of the primary of T2 and voltage variable capacitors CR5, CR6, CR7, and CR8. The RF signal is taken from the secondary of T2 and goes to the base of Q3. Q3 and Q4 are the 2nd RF amplifier and are connected in a cascode configuration. The collector of Q4 drives the double - tuned bottom coupled network consisting of L1 and L2. L1 is tuned by voltage variable capacitors CR9, CR10, CR11, and CR12. L2 is tuned by voltage variable capacitors CR13, CR14, CR15, and CR16. The double - tuned network is bottom coupled using C16 and lead inductance as the coupling reactance. The RF signal output is taken from L2 through R22 and Pin 16 to the Stator Board. The signal passes through Q3 and Q4 to the signal injection point of the mixer Q5 and Q6. The local oscillator for Band 10 operates in the same manner as in Band 9.

2.4.6 BAND 11 OPERATION

Band 11 is self-contained in the bandstrip except for the mixer. Referring to Figure 6.6 Band 11 Schematic Drawing, the RF signal goes through Pin 2 to a tap on the primary of T1. The primary of T1 is tuned by voltage variable capacitor, CR1.

The RF signal goes from the untuned secondary of T1 to the base of Q1. Transistors Q1 and Q2 are the 1st RF amplifier connected in a cascode configuration. The collector of Q2 drives the tuned circuit of L1 tuned by voltage variable capacitors CR2 and CR3. The collector of Q2 drives L1 at a tap point and is also the output of the 1st RF amplifier. The RF signal goes to the base of Q3. Q3 and Q4 are connected in a cascode configuration and are the 2nd RF amplifier. The collector of Q4 is connected to the primary of T2. The primary of T2 is tuned by voltage variable capacitors CR4 and CR5. The RF signal output comes from the secondary of T2 and goes through Pin 19 to the signal injection point of the mixer

for the 8.7 MHz IF on the Stator Board.

Referring to Figure 6.2, the RF signal comes from Pin 19 to the base of Q9, the mixer for the 8.7 MHz IF. The local oscillator signal comes from Pin 23 to the emitter of Q9. The 8.7 MHz IF signal is generated in the collector of Q9. The primary of T4001 is connected to the collector of Q9 and is tuned by C56. The IF signal comes from the secondary of T4001 and goes to TP5 on the Preamp Board through a coaxial cable.

Referring to Figure 6.6, Band 11 Schematic Diagram, Q6 is the local oscillator. Q6 is in a common emitter configuration with the collector connected to the primary of T4. The primary of T4 is tuned by voltage variable capacitors CR6 and CR7. C39 is a tracking adjustment. The feedback for the oscillator comes from an inverting winding on T4 and goes through R26 and C42 to the base of Q6. The local oscillator output from the secondary of T4 goes to the buffer amplifier, Q5. The output of the buffer amplifier goes through Pin 21 to the emitter of A2Q9, the 8.7 MHz mixer.

2.4.7 BAND 12 OPERATION

Band 12 is a self contained bandstrip which operates in a similar manner to Band 11.

The RF amplifiers for Band 12 are similar in operation to Band 11. The mixer and mixer injection is also the same as in Band 11.

Q5 is the local oscillator connected in a common emitter configuration. The collector of Q5 is connected to the primary of T4. The primary of T4 is tuned by voltage variable capacitor CR6. The feedback for the oscillator comes from the collector of Q5 through a phase shift network consisting of C37, L5, CR7, CR8, and the input impedance of Q5. CR7 and CR8 are voltage variable capacitors. The local oscillator output comes from the secondary of T4 through Pin 21 to the emitter of A2Q9, the 8.7 MHz mixer on the Stator Board.

2.4.8 BAND 13 OPERATION

Band 13 is a self contained bandstrip, except for the final mixer circuit which is on the Stator Board.

Referring to Figure 6.8a Band 13 Schematic Diagram, the RF signal enters the bandstrip at Pin 2. The RF signal goes from Pin 2 to the tap of L2, a 50-ohm impedance point at the tuned frequency. L2 and voltage variable capacitors CR1 and CR2 form the input parallel resonant circuit. The output is developed across L2 and goes to the gate of field effect transistor, Q1. Q1 is in a source follower configuration which presents a high impedance to the input tuned circuit for good selectivity. The output of Q1 goes from its source through the peaking coil L1 to the base of Q2. Q2 and Q3 are direct coupled. The collector of Q3 drives the tap of L3. L3 and voltage variable capacitor CR5 and capacitor C7 form a parallel, resonant circuit for the output of the 1st RF amplifier, Q1, Q2 and Q3. One side of L3 is AC grounded through C47 and the other side of L3 is AC coupled to CR5 and C7 through C8. The output of this tuned circuit goes from the tap on L3 through the coupling capacitor C9 and R17 to the base of Q5. Q5 and Q6 form the 2nd RF amplifier which are in the same configuration as Q2 and Q3. The collector of Q5 drives a tap on L9. L9, voltage variable capacitor CR8, and capacitor C18 form a parallel resonant circuit. One end of L9 is AC grounded through C60; the other end is AC coupled through C20 to CR8 and C18. The output of the tuned circuit goes from the tap on L9 through C21 and R28 to the emitters of Q8 and Q9. Q8 and Q9 form a balanced mixer.

In order to achieve the proper image rejection Band 13 is double converted. The 1st mixer is Q8 and Q9. The 1st LO signal comes from voltage variable oscillator, Q4. Q4 is in a common emitter configuration. The collector is tuned by the parallel resonant circuit formed by the primary inductance of T1, C12, and voltage variable capacitors CR6 and CR7. The feedback path is from the collector through the phase shift network consisting of L6, voltage variable capacitors CR3 and CR4, and L5, to the base of Q4. The 1st LO output goes from the secondary of T1 to the base of Q7. The LO signal at the emitter of Q7 drives the base of Q8. The LO emitter of Q7 drives the base of Q8. The LO signal at the collector of Q7, which is 180° out of phase with the signal at the emitter of Q7, drives the base of Q9. The RF signal is applied to the emitters of Q8 and Q9. The series tuned circuit formed by L16, C44 and C45 in the emitter of Q8 and Q9 is resonant at the 1st IF frequency of 38.7 MHz. This circuit is used to improve the IF rejection of the bandstrip. The collectors of Q8 and Q9 drive the parallel resonant circuit formed by the primary inductance of T2 and capacitors C24, C25, and C26. This circuit is resonant at the 1st IF frequency of 38.7 MHz. The output of the mixer circuit goes from the secondary of T2 to the base of Q10, the 1st IF buffer amplifier. The collector of Q10 drives the parallel resonant circuit formed by the primary inductance of T3 and capacitor C29. One end of the primary of T3 is AC grounded through C31. This circuit is resonant at the 1st IF frequency of 38.7 MHz. The output of the 1st IF buffer goes from the secondare of T3, through Pin 19 to the 8.7 MHz mixer on the Stator Board. This mixer is used for final conversion to 8.7 MHz.

The LO signal for the 8.7 MHz mixer is provided by the 30 MHz Crystal Oscillator Q12. Q12 is in a Colpitts configuration with the collector driving the parallel resonant circuit consisting of the primary inductance of T4, and capacitors C36, C37, and C38. The feedback signal goes from the junction of C37 and C38, through crystal Y1, to the base of Q11, the LO buffer amplifier. The output of Q11 goes from the

collector, through Pin 21 to the 8.7 MHz mixer on the Stator Board.

2.4.9 BAND 14 OPERATION

Band 14 is a self-contained band and operates in the following manner:

Referring to Figure 6.8b, Band 14 Schematic Diagram, the RF signal enters the bandstrip through Pin 2, and goes to the tap on L1. L1 and voltage variable capacitor CR1 form a parallel resonant circuit. The signal goes from the tap on L1 to the base of Q1, the 1st RF amplifier. The signal goes from the collector of Q1 to the tap on L5. L5 and voltage variable capacitors CR3 and CR4, form a parallel resonant circuit.

The output of the tuned circuit goes from the tap on L5, through R6 and C4 to the base of Q2, the 2nd RF amplifier. The signal goes from the collector of Q2 to L8. L8 and voltage variable capacitors CR5 and CR6 form a parallel resonant circuit. The output goes from the tap on L8, through R11 to the emitter of Q5, the RF buffer amplifier. The output of Q5 goes from the collector of the emitter of Q4. Q4 and Q6 form the 1st mixer.

Like Band 13, Band 14 has a double conversion.

The first LO signal comes from voltage variable oscillator, Q3. Q3 has a grounded base and the collector is tuned by the parallel resonant circuit consisting of L12 and L11 in parallel and voltage variable capacitors CR8 and CR9. The feedback signal goes from the tap of L11 through voltage variable capacitor CR7 to the emitter of Q3. The LO output goes from the tap on L11 through R22 to the base of Q4.

Q4 and Q6 are in a cascode configuration and form the 1st mixer. The signal is applied to the emitter of Q4 and the 1st LO is applied to the base of Q4. The 1st IF signal, 68.7 MHz, goes from the collector of Q6 to the parallel resonant circuit formed by the primary inductance of T1 and C22. This circuit is resonant at the 1st IF frequency. The 1st IF signal goes from the secondary of T1 through R28 to the base of Q7 and also through R40 to a tap on L16. L16 and C24 form a parallel resonant circuit at 68.7 MHz. This circuit is used to improve the 1st IF selectivity. Q7 is an amplifier at the 1st IF frequency 68.7 MHz. The collector of Q3 is connected to the parallel resonant circuit formed by the primary inductance of T2 and C25. The output is taken from the secondary of T2 and goes through R39 and Pin 19 to the 8.7 MHz mixer on the Stator Board which acts as the first mixer in the double conversion.

The 2nd LO signal comes from the 60 MHz Crystal Oscillator, Q8, on the bandstrip. Q8 is in a Colpitts configuration. The collector goes to the parallel resonant circuit formed by L22, C29, C30, and C31. The feedback signal goes from the junction of C30 and C31, through the crystal Y1, to the emitter of Q8. The output signal goes from the tap on L22, through C27, R36, C26, and Pin 21 to the 8.7 MHz mixer on the Stator Board.

2.4.10 BAND 15 OPERATION

Band 15 is a self contained bandstrip and operates in the following manner:

Referring to Figure 6.8c, Band 15 Schematic Diagram, the RF signal goes through Pin 2 to the input coupling loop of the first voltage tunable bandpass filter. There is a series resonant circuit from the input to ground. The circuit consists of L1, C2, and voltage variable capacitors CR2 and CR3. This circuit is resonant at the image frequency and acts as an image trap.

The voltage tunable bandpass filter is tuned by voltage variable capacitor, CR1. The signal goes from the output coupling loop through R7 and C7 to the base of Q2.

Q2, Q3, and Q4 form a direct coupled broadband amplifier. The output goes from the collector of Q3, through a ferrite bead, C28, and R24 to the input coupling loop of the 2nd voltage tunable bandpass filter. This filter is tuned by voltage variable capacitors CR7 and CR8.

The two voltage tunable bandpass filters provide the RF selectivity for the bandstrip.

The signal goes from the output coupling loop of the bandpass filter, through R27 and C43, to the base of Q4.

Q4, Q7 and Q8 form a broadband amplifier. This amplifies the RF signal in a manner similar to Q1, Q2, and Q3. The output goes from the collector of Q8 through a ferrite bead and C55 to the emitter of Q7. Q7 and Q10 are in a cascode configuration and form the 1st mixer.

The local oscillator signal for the 1st mixer comes from the voltage variable oscillator, Q1. Q1 has a grounded base, and the collector is tuned by the parallel resonant circuit consisting of L6 and L7, in parallel and voltage variable capacitors CR4 and CR5. The feedback signal goes from the tap on L6 through voltage variable capacitor CR6, and C12 to the emitter of Q1. The output signal goes from the emitter of Q1, through a coaxial cable, and through C53, R40, and C54, to the base of Q7, the 1st mixer. The collector of Q9 is tuned to the 1st IF frequency of 98.7 MHz by the parallel resonant circuit consisting of the primary inductance of T1 and C58 and C59. The 1st IF signal goes from the secondary of T1, through R45 to the input link of T2. A parallel resonant circuit tuned to the 1st IF frequency is formed by the secondary inductance of T2, C62, and C63. This circuit is used to improve the 1st IF selectivity. The signal goes from the output link of T2 through C61 to the base of Q11.

Q11 and Q12 are in a cascode configuration and are the 1st IF amplifier. The collector of Q12 drives the tap on the primary of T3. The primary inductance of T3 and capacitors C65 and C66 form a parallel reso-

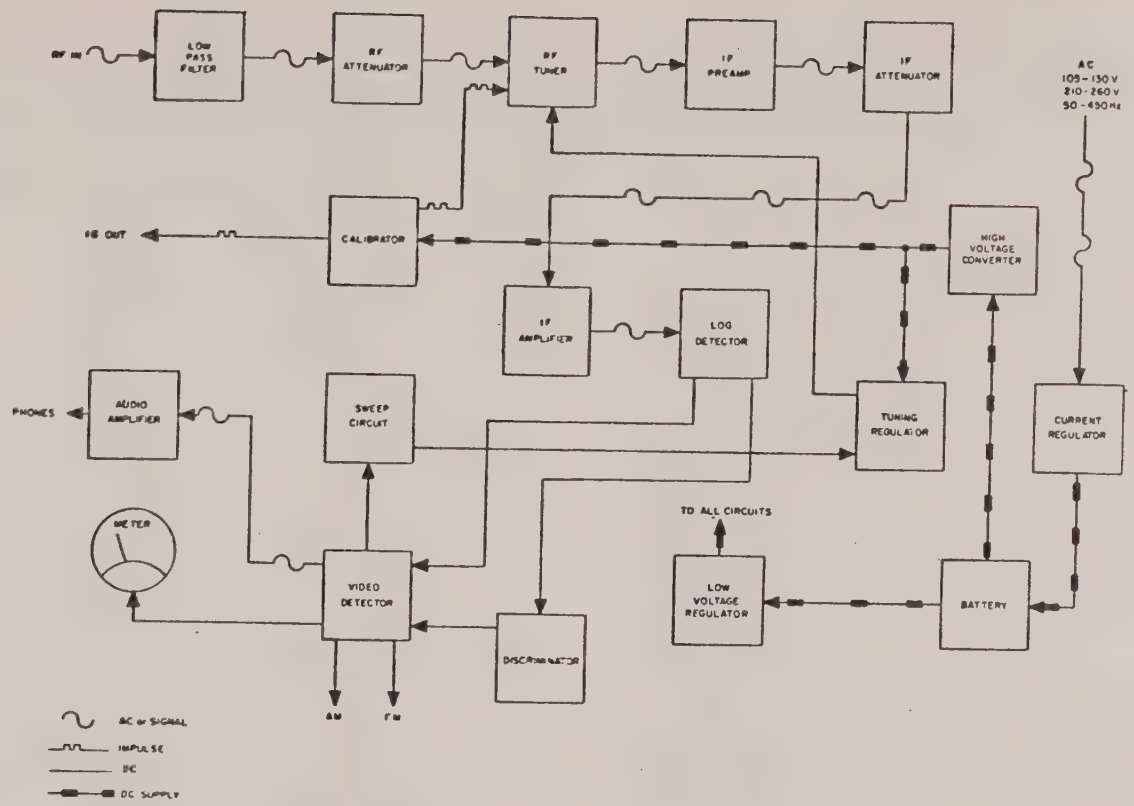


Figure 2.1 SIGNAL FLOW DIAGRAM

nant circuit tuned to the 1st IF frequency, 98.7 MHz. The output goes from the secondary of T3 through R52 and Pin 19 to the 8.7 MHz mixer on the Stator Board which in this case is the second mixer.

The local oscillator signal for the second mixer comes from the 90 MHz Crystal Oscillator Q5, a Colpitts configuration. The collector is tuned by the parallel resonant circuit consisting of L19, C36, C37, C38 and C40. The feedback signal goes from the junction of C36 and C37, through the crystal Y1, and a ferrite bead to the emitter of Q5.

The local oscillator signal goes from the tap on L19 through C41, a coaxial cable, and Pin 21 to the 8.7 MHz mixer on the Stator Board.

2.5 PREAMPLIFIER (A2A2)

Bands 1-3 and Bands 5-7 use an IF frequency of 175 kHz. The IF output of the mixer on the Stator Board goes to TP1 on the Preamp Board. TP1 is connected to the untuned primary coil of T2002. T2002 is a voltage step up transformer, with the secondary tuned to 175 kHz by C7. The IF signal comes from the tap on the secondary coil of T2002 and goes to the base of Q2, an emitter follower. A switch on the rotor of the RF Tuner controls the -6V for 175 kHz Preamp. When the proper bandstrip is in position a -6V is applied to "175 kHz -6V" terminal on the Preamp Board. This biases Q2 on and causes the diode switch CR6 and CR7 to conduct. The 175 kHz IF signal then goes from the emitter of Q2 through CR6 and CR7 to the base of Q5.

Bands 8-10 use an IF frequency of 1.6 MHz. The IF output of the mixer on the Stator Board goes to TP3 on the Preamp Board. TP3 is connected to the untuned primary coil of T3002. T3002 is a voltage step up transformer, with the secondary coil tuned to 1.6 MHz by C2. The IF signal comes from the tap on the secondary coil of T3002 and goes to the base of Q3, an emitter follower. When the proper bandstrip is in position, -6V is applied to the "1.6 MHz -6V" terminal on the Preamp Board. This biases Q3 on and causes the diode switch consisting of CR2, CR3, CR4 and CR5 to conduct. The 1.6 MHz IF signal goes from the emitter of Q3 through the diode switch to the base of Q5.

Band 4 utilizes a final IF frequency of 175 kHz, but since 175 kHz is also an RF input frequency to the band, Band 4 is double converted. The 1st IF frequency, 1.6 MHz, is generated in the mixer on the Stator Board. The 1.6 MHz, IF signal on Band 4 follows the same path as the regular 1.6 MHz IF signal, except

when Band 4 is in position, -6V is applied to "CONVERTER -6V" terminal on the Preamp Board. This energizes the 1.425 MHz, crystal oscillator, Q1. The oscillator output is taken from the secondary coil of T5001, and is applied across CR2, CR3, CR4, and CR5. In this mode of operation diode switch CR2, CR3, CR4, and CR5 becomes the second mixer generating 175 kHz. The output of the second mixer goes to the base of Q5.

Bands 11-15 use a final IF frequency of 8.7 MHz. The IF frequency comes from the mixer on the Stator Board and goes to TP5 on the Preamp Board. The IF signal goes to the untuned primary coil of T4002. T4002 is a voltage step up transformer and the secondary coil is tuned to 8.7 MHz by C1. The IF signal is taken from a tap on the secondary coil of T4002 and goes to the base of Q4, an emitter follower. When the proper band is in position -6V is applied to the "8.7 MHz -6V" terminal on the Preamp Board. This turns Q4 on. The IF signal then goes from the emitter of Q4 to the base of Q5.

Q5, Q6, and Q7 form a variable gain wideband amplifier. This amplifier has a bandpass from below 175 kHz to above 8.7 MHz, covering all three IF frequencies and is common to all three. The gain of this amplifier is varied by light-variable resistors RA1 and RA2 in the emitter circuit of Q5. These elements are connected in parallel and determine the gain of the amplifier in conjunction with R31, the feedback resistor. The resistance of the signal elements of RA1 and RA2 is varied by the current in control elements within RA1 and RA2. The control current for RA1 and RA2 comes from the "CAL" control on the front panel of the receiver to the "GAIN" terminal on the Preamp Board. The control signal then goes through a dual emitter follower, Q8 and Q9 providing temperature compensation. The control signal goes from the emitter of Q9 to the control elements of RA1 and RA2 in series. This yields approximately 20 dB of gain control and is used to calibrate the receiver.

The output of the wideband amplifier comes from the emitter of Q7. The IF signal goes from the emitter of Q7 through R34 to switch S1AR. S1AR, S1AF, S1BR, and S1BF and resistors R34, R38, R39, R43, and R44 to form the IF step attenuator. The IF step attenuator is mechanically linked to the RF step attenuator. Their values are such that each step of the front panel control gives an overall of 20 dB attenuation, but as the attenuation is increased from the 0 dB position, the noise level on the meter decreases, in-increasing the dynamic range. (see Fig. 2.1)

The output of the IF attenuator is at Pin 3 of S1BR. The IF signal goes from Pin 3 of S1BR to connector A2J3 on the RF Tuner housing. The IF signal then goes through a coaxial cable to A3J1 on the IF Amplifier Assembly.

The output of the IF step attenuator at Pin 3 of S1BR also goes to the base of Q10, an emitter follower with the output at the emitter. This signal goes through R41 to connector A2J2 on the RF Tuner housing. This signal is the PRE IF OUTPUT and goes from A2J2 through a coaxial cable to A1J101 on the rear receiver housing.

2.6 IF AMPLIFIER (A3)

The EMC-25 uses three different final IF frequencies and three IF amplifiers. Each IF amplifier has a similar selectivity curve and configuration. The IF selectivity curve in the WIDE BANDWIDTH position is that of 5 under-coupled double-tuned circuits with a coupling coefficient of 0.85.

Although the center frequency, the bandwidth, and the gain of each IF amplifier is different, operation of all the IF amplifiers remains basically the same.

An IF signal comes from A2J3 on the Preamp Board to A3J1 on the IF amp. The switch mounted on the rotor in the RF Tuner turns on the proper IF strip by applying -6V to the proper IF (eg. "8.7 MHz -6V" turns on the 8.7 MHz IF amplifier while the other IF amplifiers stay off).

The 8.7 MHz IF signal goes from A3J1 through C1, L4001, and R1 in series to the emitter of Q1. C1 and L4001 are series resonant at 8.7 MHz and present a 50 ohm impedance to J1. This series tuned network, the tank circuit at the input to the Preamp, and the tank circuit at the output of the mixer on the Stator Board, are equivalent to one double-tuned network.

Q1 is the 1st stage of IF amplification. The collector of Q1 is tuned by a double-tuned under-coupled network consisting of L4002, C5, the primary inductance of T4004, and C6. Capacitor C4 is the coupling reactance. This network is top coupled and each half has an equal Q factor. Q4 and the unloaded Q of L4002 determine the circuit Q of the 1st half. R5, the unloaded Q of T4003, and the load resistance reflected from the secondary of T4003 determine the circuit Q of the 2nd half.

Each amplifier stage operates in the same manner and is double-tuned and under-coupled to successively increase the "Q" factor to present the proper bandwidths to the Log Detector.

When the "BANDWIDTH" switch on the front panel of the receiver is in the WIDE position, the "Bandwidth Command" voltage is -6V. This causes diode switches CR1 and CR3 to be open (off) and diode switch CR2 to conduct in the on position. Then the output of the 1st stage goes from the secondary of T4003 through CR2 to the emitter of Q4, the 2nd stage of IF amplification.

When the BANDWIDTH switch is in the NARROW position, the "Bandwidth Command" voltage is +12V. This causes diode switches CR1 and CR3 to conduct, or to be in the on position, and diode switch CR2 to be open or in the off position. Then the output of the 1st stage goes from the secondary of T4003 through CR1 and R6 to the emitter of Q2. The single tuned circuit

in the collector of Q2 determines the NARROW bandwidth. The tank consists of L4004 and capacitor C12. R11 is the loading resistor. The output of the tank goes through R12 to the gate of the source follower Q3. The output of Q3 goes from the source through CR3 to the emitter of Q4, the second stage. The tank in the collector of Q2 has a very high Q. R11 is factory adjusted for the proper narrow bandwidth. R6 is factory adjusted so that the gain in NARROW band is the same as in WIDEBAND.

The output of the last stage of each channel goes to an emitter follower, Q7, that presents the proper impedance match to the Log Detector. A lower level signal is also delivered from the emitter follower to the POST IF OUTPUT.

The outputs of all three channels are combined through A3A1, R32, A3A2, R33, and A3A3, R32, and go to J3. This output, the POST IF OUTPUT, then goes through a coaxial cable to A1J102 on the rear of the receiver.

2.6 N OPTION (Crystal Filter) (A10)

2.6.1 GENERAL

The N option to the EMC-25 consists of an internally mounted crystal filter to provide a third, narrower bandwidth. This filter is located in a shielded housing within the EMC-25 main compartment. It shapes the bandpass response characteristic to a 4-pole Gaussian response. The normally supplied ultra narrow bandwidth is nominally 1% of the wide bandwidth and 10% of the narrow bandwidth.

The filter assembly consists of three IF channels (175 kHz, 1.6 MHz, and 8.7 MHz) corresponding to the three IF frequencies of the EMC-25, each channel having a crystal filter and an amplifier. It is located in the circuit between the IF Amplifier and Log Detector. When correctly adjusted, the over-all insertion loss through the filter option is 0 dB which allows the gain characteristic of the EMC-25 receiver to remain unchanged.

2.6.2 CONTROL PARAMETERS

The front panel BANDWIDTH switch selects voltages supplied to the 0.1 NB Command line; +12 volts is applied in the 0.1 NB position and an open circuit in the WB and NB positions. +12 volts supplied to the filter stage will forward bias CR1, CR4 and CR7 and back bias CR2, CR3, CR5, CR6, CR8, and CR9 allowing signals from the quartz crystal filter to be connected to the amplifier. An open circuit supplied to the command line will back bias CR1, CR4, or CR7 and forward bias CR2 and CR3, CR5 and CR6, or CR8 and CR9, by-passing the filter. -6 volts supplied by the IF command circuit of the EMC-25 to any of the amplifiers causes that particular channel to operate. In order to facilitate receiver tuning in the 0.1 NB position, the EMC-25N is equipped with a dual FINE TUNE control.

An adjustment in each by-pass circuit of the three channels, (R3, R26, R48) allows the insertion loss of this circuit to be adjusted to match the loss of the corresponding quartz crystal filter. The feedback amplifier, consisting of three transistors, S15649, 2N4250 and 2N3690, regains the insertion loss through the filter stage and is adjusted to maintain 0 dB loss. Each channel has an individual gain control (R14, R37, R59).

2.6.3 REMOTE OPERATION

With the proper connections made to the REMOTE connector (Fig. 3.16) and the BANDWIDTH switch placed in the 0.1 NB position, bandwidth selection may be operated remotely.

2.7 DETECTION SYSTEM

2.7.1 GENERAL

The detection system of the EMC-25 is contained in three individual modules, the Log Detector (A4), Video Detector (A1A1), and the Discriminator (A8). The Log Detector and the Discriminator are located in the main shielded compartment and the Video Detector is attached to the bulkhead that separates the control section from the main compartment. The input to the detection system is a linear IF signal from the output of the IF amplifier. The three IF amplifiers have dynamic ranges of approximately 90 dB between noise and the limit levels. Outputs from the detection system include the front panel meter, audio, AM VIDEO, FM VIDEO and a DC correction voltage to the AFC circuit. Amplitude detection is done in two steps; the Log Detector simultaneously envelope detects the IF signal and provides an output proportional to the log of the peak value of the IF signal, then the Video Detector detects the video signal from the Log Detector output and applies the selected charge and discharge time constants. FM detection is accomplished in the Discriminator and the audio signal is recovered in the Video Detector. Refer to Figure 2.2 for a block diagram of the detection system.

2.7.2 LOG DETECTOR (A4)

Following each IF Amplifier, a seven-stage sequential detection system is used for a logging detector. The design is unique in its simplicity, in that no circuits or delay lines are used. Matched precision components preclude the need for any adjustment of this circuit other than the maximum and minimum scale points. There are two outputs from the circuit. One is a limited IF signal, the other a DC-coupled reproduction of the logged envelope of the signal.

Figure 2.3 illustrates a single stage of the log

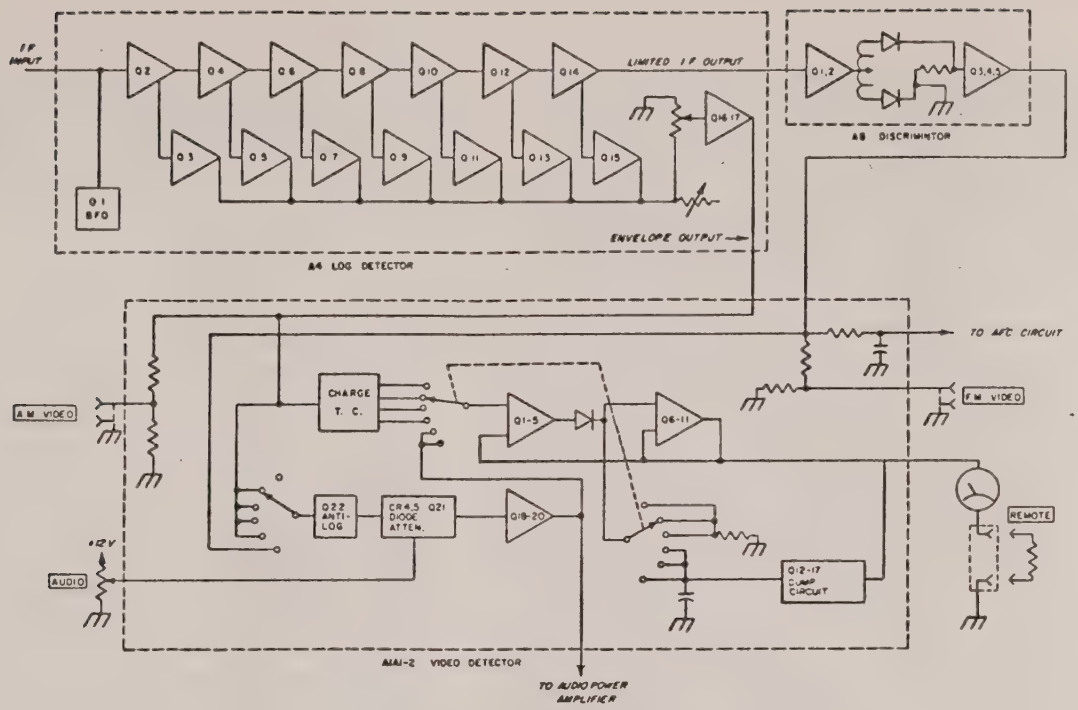


Figure 2.2 DETECTION SYSTEM

detector. There are seven similar stages with the IF output of each stage tied in turn to the input of the next stage. The video output of each stage is in parallel with the output of all other stages. The operation of all stages is identical.

Q4 is connected as a grounded emitter amplifier and Q5 is connected as a grounded base amplifier. For small signal levels, Q4 acts as a linear amplifier with the gain approximately determined by the ratio between the emitter resistor (R10) and the collector load which consists of R9, R14 and the input impedance of Q6. The values of these components are chosen so that the input impedance of Q6 has a second order effect. Under these conditions a fixed current flows in Q5 determined by R10, R11, and R12. Transistors Q4 and Q5 are matched for both H_{FE} and V_{BE} and all tranistors within a particular log strip are selected from a particular H_{FE} grouping.

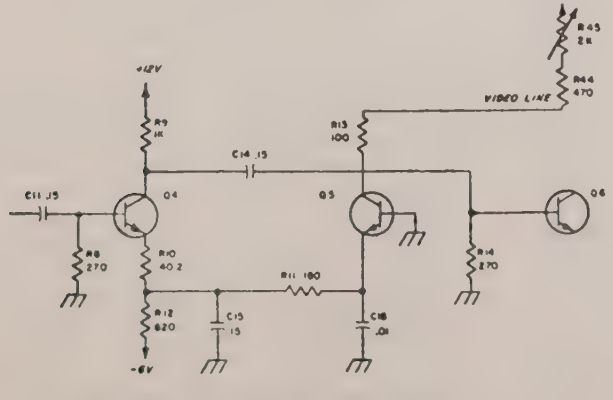


Figure 2.3 Single Stage (Log Detector)

Under large signal conditions Q4 current limits to provide a square wave to the next stage. Simultaneously, detection takes place in the emitter-base junction of Q4 causing C15 to charge to a more positive potential. The combination of R11 and C16 further filters any IF frequency at this point so that a DC potential is presented to the emitter of Q5. At this point Q5 will be cut off, resulting in no collector current flow. Component values are proportioned so that the video stage associated with Q6 will be cut off at approximately the same time as Q4 begins its detection.

As signal level increases, each video stage, commencing with the last one in the strip and proceeding towards the input, will cut off. The collector currents of Q5 and all the other video stages are totaled together in R44 and R45, resulting in a DC voltage, appearing at the point labeled "video line", proportional to the log of the input signal value. The time constants are proportioned so that the signal on the video line will follow the peak value of the instantaneous signal amplitude. Complementary emitter followers, Q16 and Q17, provide a low impedance output to feed the video detector. Q14, the output IF stage in each of the strips, provides a limited IF signal output to the discriminator.

In each of the logging detector strips, transistor Q1 is a low level L-C oscillator actuated by the TUN-

ING AID switch. They are offset from the IF center frequencies by approximately 1 kHz and are loosely coupled to the first amplifying stages (Q2). The oscillator output is amplified sufficiently by the time it reaches Q14 to mix with low level CW signals in this stage and provide an audio frequency output from the logging detector.

2.7.3 VIDEO DETECTOR (A1A1)

The Video Detector is located at the interface between the heavily shielded and non-shielded portions of the analyzer. Its purpose is to further detect and apply correct time constants to the signal envelope waveform supplied by the logging detector. To obtain accurate linear detection at this point and extremely long stretch times required for peak detection, an active detector is used. Certain applications involving the use of slow speed recorders and peak detection in the analyzer require the periodic "dumping" of the charge in the detector circuit (See Fig. 2.2). To determine how long a signal is to be held in the peak detector circuit before being dumped, a linear differential amplifier is utilized to sense the rate of amplitude change of detected signals and to vary the dump time accordingly. The output of the Video Detector feeds both the internal indicating meter and the analyzer's "Y-output". Two models of the Video Detector are used with A1A1-2 being utilized in all serial numbers higher than 25140.

In both types of Video Detectors AM VIDEO is recovered from the video output of the log detector (A4) by a 1000 ohm and 100 ohm voltage divider. This output is 10^{7} of the amplitude of the log detector output (when unterminated), DC coupled, logged, and of 90 ohm impedance. FM VIDEO is similarly recovered from the Discriminator (A8). The Discriminator output is also integrated by a 100 K ohm resistor located in the video detector and a pair of 2.2 f capacitors located on A1J6 for use as the AFC error signal.

2.7.3.1 VIDEO DETECTOR (A1A1-1)

Transistors Q1 - Q9 comprise a differential input operational amplifier. CR4, a low leakage diode, is located in the feedback loop of this amplifier. The feedback loop is connected so that the amplifier has a gain of unity; due to this, the forward impedance of diode CR4 is reduced by the approximate ratio of the open-closed loop gain of this amplifier and is transformed into what is commonly referred to as an active detector, which effectively lowers the knee of the diode to approximately 10 millivolts. Transistors Q10 thru Q17 comprise another operational amplifier whose feedback gain is 3. Both operational amplifiers use field effect transistors in their input stages to obtain an extremely high impedance. Time constants for the active detector are located on switch section S1B and S1C. When utilized as a peak detector, C21 serves as the storage element. The only discharge path for C21 is through the reverse impedance of diode CR4 and the inputs of Q3 and Q11. Under these conditions extremely long discharge times can be obtained.

Should it be desired to plot amplitude vs. frequency utilizing the peak detector function, many signals would be missed using a fast sweep range.

The dump circuit operates as follows:

The function of the dump circuit is to sense the rate of increase of input signals, and if the signal exceeds a specified rate of increase, cause the dump circuit to change to a very slow discharge time for a specified length of time, and then to revert to its quiescent state of fast discharge. With the DUMP control fully counter-clockwise (S2 open), Q23 is turned off, permitting both anode and cathode of CR5 to be maintained at the same voltage eliminating any current flow through it. The discharge time constant would therefore be extremely long as previously described. When the DUMP control is turned clockwise S2 closes, completing the path from the emitter of Q23 through R63 and R66 to the -6 volt power supply. As the base of Q23 is maintained at a fixed potential, this transistor saturates, causing C21, the storage capacitor, to be discharged through R58 to a potential slightly below ground. Therefore the quiescent condition of the dump circuit with no signal received is one of a fast charge time and a moderately fast discharge time.

The rate of rise of input signals is sensed by Q19, a differential amplifying transistor. Both bases of this transistor are connected through nearly identical impedance back to the meter output of the second operational amplifier. On one of the bases, C24 in conjunction with R32 and R31 (DUMP) form a variable integrating network. If a fast rising signal is received, the base of the transistor connected to C24 will rise in voltage much slower than the opposite base, resulting in a large unbalance of the collector currents of Q19. Due to this unbalance, transistor Q24 is turned on, drawing current through R66 and turning off transistor Q23. With Q23 turned off, the detector circuit changes to its long discharge state. When the voltage on C 24 has risen to the same value as that on the other base of Q19, Q19 will turn off, returning the circuit to its quiescent state, this results in the discharge of capacitor C21 if no signal is presented at the output of the first operational amplifier. Transistor Q18 is utilized only at the time of discharge of C21 to insure that C24 also discharges quickly to await the arrival of another signal.

To recover the distorted audio signals caused by the logging process appearing at the input of the Video Detector, a metal-oxide field-effect transistor (Q20) is used in its square-law-mode. The audio signal is DC coupled to the gate and is recovered undistorted across R38 in the drain circuit. Resistors R40, R41,

and diodes CR2 and CR3 act as an attenuator for those audio signals. Current through these diodes is determined by the amount of voltage appearing on R42 and R44. The amount of audio signal appearing across CR2 and CR3 is too small to be distorted by their nonlinearity. Q22 and Q21 comprise a feedback amplifier designed for a gain of 200. This amplifier feeds the Audio Amplifier A1P2 and when in the AM and FM MODULATION positions, feeds the first operational amplifier in the Video Detector. In the FM position the output of the Discriminator is AC coupled to the input of Q20 and is too small in magnitude to be distorted by it.

When the detector switch is set to either the AM or FM MODULATION modes, the two operational amplifiers are connected in such a way that the audio information from the audio output is half-wave rectified and averaged.

2.7.3.2 VIDEO DETECTOR (A1A1-2)

Video Detector (A1A1-2) also contains two operational amplifiers. The first operational amplifier is composed of transistors Q1-Q5. The second operational amplifier is composed of transistors Q6-Q11. The first amplifier compares the difference between the input signal received from the Log Detector (base of Q1) and the output signal fed to the meter (base of Q2). Diode CR1 rectifies the output of the first operational amplifier. Switch sections S1A and S1B both apply time constants to the signal. In the SLIDEBACK and PEAK positions, the signal is passed directly to the base of Q1. In the CARRIER position the signal is passed through a 600 m sec integrator and in the QUASI-PEAK position through a 2 m sec integrator. At S1B a DC bias is applied in the SLIDEBACK position from the arm of the slideback pot to reverse bias CR1. Any signal peak exceeding this bias value is developed across R35 and fed through S1C to the audio amplifier. In the CARRIER and QUASI-PEAK positions a 600 m sec RC network is connected to insure the proper discharge time for the QUASI-PEAK function and to provide further filtering for the CARRIER position. In the PEAK, AM and FM MODULATION positions, this detector is utilized as a peak detector, with C9 storing the charge. The only discharge path for C9 is through CR1, Q6 and CR2.

The utilization of a long discharge time is necessary for obtaining the true peak value of signals when making amplitude versus frequency plots with an X-Y plotter. The charge on the detector must be removed after the plotter pen has fully responded or succeeding signals will be masked. A circuit is included in the Video Detector to maintain long discharge time constants only upon receipt of a signal and for a dwell time set by the DUMP control to cause the detector to revert to its short discharge time constant. This circuit is composed of transistors Q12 thru Q17, CR2, and associated components. The long discharge time constant occurs when C9 discharges into the reverse impedance of CR1, CR2 and the gate of Q6. The short discharge constant occurs when C9 discharges through R33 to ground potential. With the DUMP control rotated fully counter-clockwise, switch S2 is open, resulting in no current flow through Q13. With Q13 turned off, Q16 is also turned off, connecting the series combination of R33, CR3, and R30 between the input and output of the second operational amplifier. As the input and output of this amplifier are at the same potential, there is no current flow through CR2, resulting in the long discharge time constant. When the DUMP control is advanced so that S2 is closed, the circuit is designed to be slightly unbalanced so that Q13 is conducting, causing Q16 to conduct. Current flow through Q17 maintains the emitter of Q16 at approximately -.7 volts so that when Q16 saturates, its collector is also approximately -.7 volts. Therefore, the anode of CR2 will be approximately at ground level resulting in C9 discharging through R33 to ground. The rising voltage from the output of the second operational amplifier is coupled to the bases of Q12 and Q15. The presence of C5 and C6 in the circuit prevent the base of Q14 from simultaneously rising. Thus, under these conditions, Q15 is cut off and the emitter of Q14 rises in potential slowly as determined by the time constant of C5, C6, R28 and R29. Q13, is also cut off, thereby cutting off Q16 and returning the circuit to the long discharge time constant. When the emitter of Q14 has risen sufficiently, Q13 once again will conduct, and the circuit will revert back to the short time constant discharge. If the signal is still present at this time, it will continue to read properly on the EMC-25 meter and if not present, the detector will be caused to discharge with a time constant of C9 and R33. The dwell between the receipt of the signal and the reversion of the circuit to the short discharge time constant is controlled by both the C5, C6, R28 and R29 time constant and the amount of increase in signal level.

Operation of the audio circuitry and the modulation monitoring circuitry is identical to that described for Video Detector A1A1-1 previously with the exception that AM and FM MODULATION detection is peak detected rather than average detected.

2.7.4 DISCRIMINATOR (A8)

Each of the three log detector channels produces a limited output of approximately 1 volt RMS. These outputs are fed to the three inputs of the Discriminator, A8. In each channel of the Discriminator, transistors Q1 and Q2 further limit and amplify the signal before applying it to the discriminator transformer. Diodes CR1 and CR2 and the associated components form a conventional Foster-Seely type discriminator. A two section RC filter follows this to further remove IF frequency components from the video signal. Transistors Q3, Q4, and Q5 form an operational

amplifier connected for a gain of unity which presents a high impedance to the discriminator and a low impedance to the output. As in the IF amplifier and log detector, the -6 volt supply leads are switched to each of the channels as determined by the RF tuner band selector. Due to the fact that the output signal must swing both positive and negative, diode CR3 is included to completely disconnect those unused channels from the common output line.

2.8 CONTROL SECTION (A1)

2.8.1 CALIBRATOR (A1A2)

Amplitude calibration of the EMC-25 is accomplished by means of a built-in impulse generator. In this generator, a mercury wetted reed switch is installed in the center conductor of an open-circuited coaxial line. This line is charged to a voltage determined either by the band in use or an external voltage supplied through the REMOTE connector. It produces an impulse of the DC voltage supplied to it whose width is controlled by the distance between the switch contact and the open end of the coaxial line. Failure can only occur through loss of the charging voltage or breakage of the switch. The result is a reliable and repeatable calibration source. A 6 dB, 50 ohm attenuator is built into the impulse calibrator in order to improve its impedance characteristic and to result in a more uniform output.

The reed switch is driven by a solenoid external to the coaxial structure. The solenoid is driven by a grounded emitter transistor, Q3, which in turn is driven by an asymmetrical multivibrator consisting of Q1, Q2 and associated parts. The repetition rate of this multivibrator is approximately 54 Hz.

An 84 volt neon regulator tube (V1) is included on the Calibrator assembly to provide regulated voltage for the impulse generator contact. When operated on internal power, the impulse generator contact is fed through a voltage divider consisting of R2 located on the Calibrator assembly, and one of two resistors located on the Band Selector, A1A5. These resistors are chosen to provide nearly equal meter readings for the varying bandwidths encountered.

2.8.2 SWEEP TUNE (A1P1)

The Sweep Tune card A1P1 is located on a bracket behind the meter as is the Audio circuit, A1P2. This card (A1P1) contains two separate circuits, a differential amplifier consisting of Q1 and Q2 and CR2, CR3 and transistors Q3 and Q4. The differential amplifier serves four purposes:

a) The input at Pin 7 is the main tuning input. It possesses a high enough impedance with respect to the tuning potentiometer so that it does not load it and effect the linearity of tuning, as well as providing the same high impedance when external control is used.

b) At Pin 5 an error signal is added to the second differential amplifier input from the FINE TUNE potentiometer (R2).

c) At Pin 3 an error signal is added from the filtered Discriminator output appearing in the Video Detector assembly (A1A1) for use in the AFC system.

d) The junction of R6, R10, and R11 is a current summing point. Therefore, this input responds to the sum of the AFC and FINE TUNE error signals which aid in the correction of small drifts in the Discriminator center frequency.

The range of the manual tuning potentiometer is adjusted by R2 located on this board, and the balance of the amplifier is controlled by R12 which is labeled LOW FREQ.

Also located on this circuit board is a one minute sweep circuit so that the EMC-25 and an X-Y plotter can be utilized to make an amplitude vs. frequency plot exclusive of any other automating equipment. This circuit is of the familiar boot-strap type:

A linear sweep is developed by means of charging C2 with a constant current source. Transistors Q3 and Q4 form a complementary emitter follower whose purpose is to present an extremely high impedance to the charging capacitor C2 and a low impedance to the output load. A feedback capacitor C1 is connected from the output (Q4 emitter) to the junction of CR1 and R8. The base of Q3 and the emitter of Q4 are maintained at an approximately equal potential and C1 tends to maintain a constant potential. The rising voltage at the junction of CR1 and R8 causes CR1 to become reverse biased, and the only discharge path for C1 is through R8. This point will then rise above the power supply voltage and a nearly constant potential will be maintained across R8 resulting in a constant current through C2 and a linear voltage vs. time relationship for the entire length of the sweep. As the base of Q3 approaches +12.6 volts, CR2 will conduct ending the sweep. The START push button discharges C2.

2.8.3 AUDIO AMPLIFIER (A1P2)

The Audio Amplifier board A1P2 is located adjacent to the Sweep Tune board A1P1.

Transistors Q1 and Q2 are grounded emitter stages and Q3 and Q4 in the output stage are operated as emitter followers. Diodes CR1 and CR2 provide temperature compensation for the output stage, resulting in constant quiescent collector current flow. The output transistors are protected against low external impedances and short circuits by R3 and R7. The gain of the amplifier is controlled by the ratio of the feedback resistors (R4 and R6).

2.8.4 EXTERNAL CONTROL

Through use of the outputs provided at the REMOTE connector on the front panel of the EMC-25, many functions may be remotely programed. Connections of many of the front panel controls to the controlled circuits must be made through the front panel REMOTE connector. The proper jumpers for these manual functions are contained in the accessories and the DUMMY PLUG. A Connector Junction Box, Model CJB-25 provides for the simultaneous use of accessories as limited by their internal jumpers.

Outputs from the receiver include a center channel tuning indications, X and Youtputs for X-Y plotting, binary switch closure indication of band in use, and sufficient power to operate a number of external accessories.

2.9 R OPTION (A9)

Instruments having built-in provision for remotely changing frequency bands are designated EMC-25R. Components added to the EMC-25 are a DC gear-motor, an electro-mechanical clutch, a microswitch and a printed circuit board containing circuitry to actuate bandswitching (A9-1). On the circuit board, transistor Q1 actuates relay K1 in response to a +2 to +12 volt signal on the Step Command Line. Diode CR1, in series with the base lead, provides reverse voltage protection and some noise immunity. Microswitch S1 senses detent position. When the K1 contacts are closed, motor B1 and clutch K2 are actuated, rotating the turret mechanism. As soon as the mechanism has rotated out of the detented position, S1 closes, sending current through R3 to the base of Q1, turning it on eventhough the step command signal may no longer be present. Upon reaching the next detented position, S1 opens, turning of Q1, releasing L1, releasing the clutch and removing motor power unless there is still a signal on the Step Command Line in which case the mechanism will continue to step.

Diode CR2, in series with the motor, prevents the voltage generated by the motor during its coast-down period from keeping the clutch engaged. Diode CR3 prevents the counter EMF of the clutch from damaging K1 contacts.

Late model EMC-25R's utilize a relay-less circuit (A9-2) to actuate the motor and clutch. Transistors Q1, Q2 and Q3 are normally turned off by the resistors connected from base to emitter in each stage. When a +2 to +12 volt signal appears on the Step Command line a proportional current enters the base of Q1, saturating it. Q2 and Q3 are also caused to saturate, actuating the motor and clutch. Microswitch S1 senses detent position. As soon as the mechanism has rotated out of the detented position, S1 closes, connecting the collector Q2 through CR3 and R3, turning Q1 and Q2 on although the step command signal may no longer be present. When the mechanism reaches the next position. S1 will open, turning off the transistors unless the step command signal is still present. The collector of Q2 is chosen as the feedback point for S1 because no current can flow to the positive supply unless the Step Command Line is first actuated. Should S1 be connected to the positive supply, the clutch and motor would be actuated by a manual rotation of the panel band-switching knob.

Diode CR3, in series with the motor, prevents the voltage generated by the motor during its coast-down period from keeping the clutch engaged. Diode CR4 prevents the occurrence of a large inverse voltage across the clutch upon its release which would damage Q3.

2.10 ACCESSORIES

2.10.1 GENERAL

A wide range of programing, pick-up, and convenience accessories are available for the EMC-25. Programing accessories are those which utilize the inherent capability of the EMC-25 for remote control to provide an automated capability. Pick-up devices extend the EMC-25 capability from a two-terminal tunable voltmeter to a field and current measuring device. Convenience accessories extend the utility of the instrument by providing audible outputs, convenient junction points and remote meter indication, etc.

2.10.2 PROGRAMING ACCESSORIES

The model ESC-125A, Programmer utilizes the sweep, bandswitching, and X and Y output capability of the EMC-25 to provide completely automatic amplitude vs. frequency X-Y plotting of the spectrum from 14 kHz to 1 GHz. The rapid sweep capability of the EMC-25 is utilized by the SPD-125 Spectrum Display Module. The CRT of this accessory can display an entire EMC-25 octave band at one time, a narrower band, or provide an amplitude vs. time display of modulation on a selected carrier.

2.10.3 PICK-UP DEVICES

The three low frequency antennas are powered by the EMC-25 and switch bands remotely according to the binary circuit indication of the band in use of the EMC-25. Covering the 14 kHz-25 MHz range, the active vertical antenna, Model RVA-25 electronically converts the extremely high impedance of the rod antenna to the low impedance input of the EMC-25 through use of an amplifying network that provides a high sensitivity to the fields monitored. Antennas, Model RVR-25 and ALR-25 contain only passive matching networks. All three antennas switch bands automatically as the EMC-25 bands are switched and each has a built-in network for verifying calibration.

The BDA-25, Broadband Dipole Antenna is utilized across the 25-200 MHz frequency range. This antenna employs the use of 3 fixed-tuned dipole arms. From 50 MHz-100 MHz, one set of extensions should be used; from 25-50 MHz, both sets of extensions should be used. The antenna may be used across the entire range 25-200 MHz without extensions, if some sensitivity loss at the lower frequencies is permissible.

The 200 MHz - 1 GHz frequency range is covered by the LCA-25, Log Conical Antenna. This antenna is a broadband device that is circularly polarized and is designed for RFI/EMC specification testing and general use.

2.10.4 CONVENIENCE ACCESSORIES

For obtaining an audible output from the EMC-25, two types of 600 ohm head phones are available. The EEF-25 are provided for standard voice frequencies and the EHF-25 permit high fidelity reception. When aligning antennas and performing similar tasks, the Remote Indicating Meter, Model RIM-25, is a useful accessory. The CJB-25 Connector Junction Box is furnished with each EMC-25 to permit the simultaneous use of remote antennas and programing accessories. Its function is described in Section III.

SECTION III
OPERATION INSTRUCTIONS

3.1 GENERAL

3.1.1 This section provides instructions for operation of the Interference Analyzer, Model EMC-25 in all modes. Instructions are also included for pre-operating calibrations, accessory operation and reading interpretation.

CAUTION

Read all information in this section carefully before attempting operation. Improper operation can cause costly damage to the instrument.

3.2 UNPACKING

3.2.1 Remove the instrument carefully from the shipping carton and examine thoroughly for shipping damage. If there is any damage, replace the instrument in the shipping carton and immediately inform the manufacturer and the shipping company of the nature of the damage, the serial number of the instrument, the delivery date, and the invoice number.

3.2.2 Check contents of the carton against shipping slip to be sure that all components and accessory items ordered are present. Notify the manufacturer immediately of any missing items.

3.3 ELECTRONIC SHIPPING DAMAGE

3.3.1 Before leaving the factory, this instrument was subjected to a complete operational check. However, it is possible that electronic damage may have occurred in transit. It is desirable, therefore, to check the operation of the instrument as soon as possible after unpackaging.

To do so, perform the calibration tests outlined in paragraph 3.7. If the instrument does not calibrate using the referenced procedures, inform the manufacturer giving the basic information required in paragraph 3.2.1.

3.4 POWER REQUIREMENTS

3.4.1 Unless otherwise specified on the purchase order, the EMC-25 is normally wired for operation with the following power supplies.

a) Internal (self-contained) battery operation.
b) External 105 to 130-volt AC, at 50 to 450 Hz.
c) External 30 to 56-volt DC.

NOTE

A switch on the battery charger compartment cover changes power supply to operate from 105 to 130 volts AC or 210 to 260 volts. The fuse must be changed as indicated when changing the supply voltage range.

3.5 BATTERY POWER SUPPLY

3.5.1 The battery pack (BAT-25) supplied with the instrument incorporates multiple nickel-cadmium cells in a modular design which provides for individual cell replacement. The battery can be used for eight hours of sustained operation without recharging. It will fully recharge after such usage in sixteen hours. To recharge the battery, connect the instrument to an external AC source. Battery charging is automatically controlled by the instrument and will occur with the POWER switch either in the ON (up) or OFF (down) positions. This provides operating capability during the recharging phase.

3.5.2 Because testing with this instrument is usually performed sporadically for short periods of time, it is difficult to know the charge condition of the battery. The front panel Battery Test Switch indicates only if the regulating circuits are operating properly. It does not indicate exact degree of charge or balance condition of the battery or of voltage to the instrument. The battery test light will light when the switch is depressed if the EMC-25 is operable.

3.5.3 For most efficient operation this instrument should be connected to an external AC source, whether turned OFF or ON, and kept on charge even when in storage. It cannot be overcharged.

3.5.4 The internal battery is automatically used when the instrument is fully disconnected from the power line. Normally the instrument should be kept on AC and near full charge at all times for best overall operation.

3.5.5 The instrument can also be operated from an externally connected battery. To do so, connect the PDD-25 power cord to the power input connector on the rear of the instrument, then connect the red clip to the positive battery terminal and the black clip to the negative battery terminal.

CAUTION

Do not ground the battery terminals or establish a reference ground. Let the external supply "float" above ground. The internal battery must be left in the instrument and connected when the instrument is being operated from external AC or DC operation to provide proper capacity.

3.6 INSTALLATION

3.6.1 The EMC-25 is designed for bench-top operation, field-portable operation, or for installation in a conventional 19-inch equipment rack.

3.6.2 Rack mounting requires the use of two adapter mounting brackets (ABM-25). Using these brackets, install the instrument by the following procedure. (See Figure 3.1.)

a) Remove the four plastic feet.
b) With six 3/8-inch No. 10-32 binder head screws, fasten brackets to sides of instrument at matching screw holes.
c) Before installing in equipment rack, provide underneath support sufficient to carry the weight of the instrument.

3.7 PRE-OPERATIONAL CALIBRATIONS

3.7.1 All measurements made with the EMC-25 are based on its calibration as a two-terminal voltmeter. The built-in calibration standard is an impulse generator whose spectrum is essentially flat between 14 KHz and 1 GHz. CW calibration charts, made necessary by front end gain variations and slight overall bandwidth variations, are provided for each instrument. Calibration charts are also provided for making broadband measurements. Figure 3.2 is a typical calibration chart. Figure 3.3 illustrates front panel controls for calibration. Figure 3.4 shows all panel controls and paragraph 3.10 details all functions.

3.7.2 CW CALIBRATION. To calibrate the EMC-25 for directly reading signal levels in

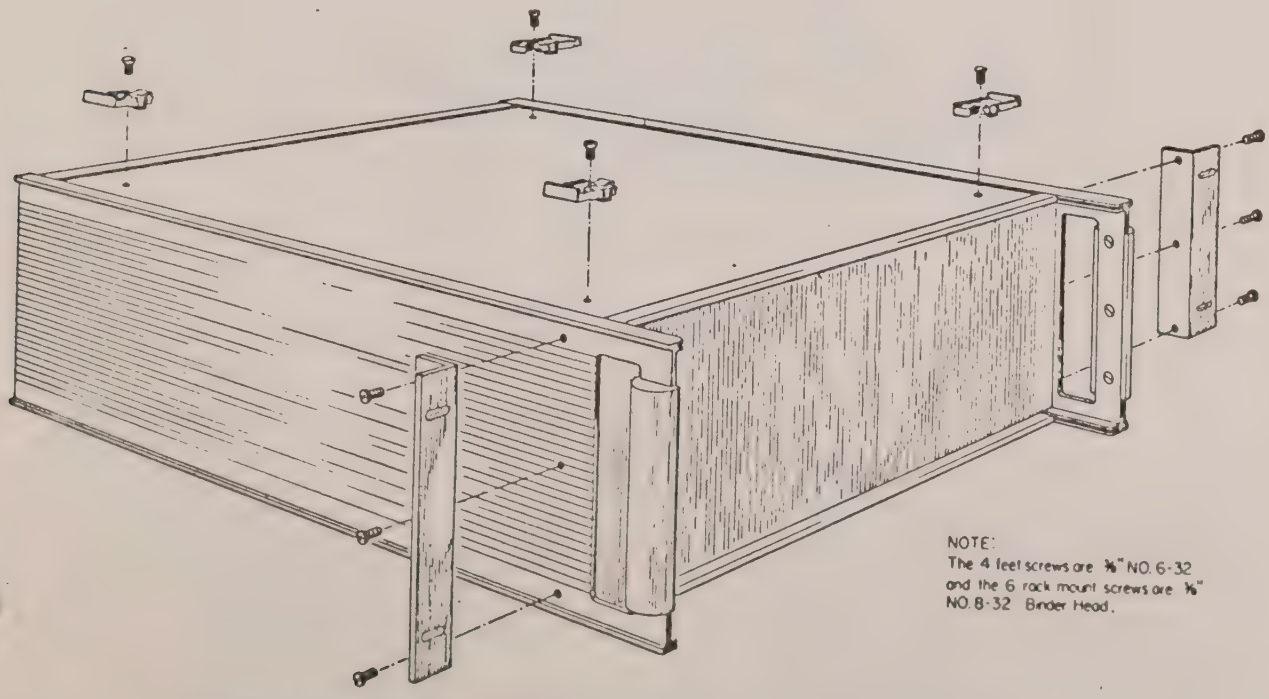


Figure 3.1 Interference Analyzer (Inverted), Installation Drawing

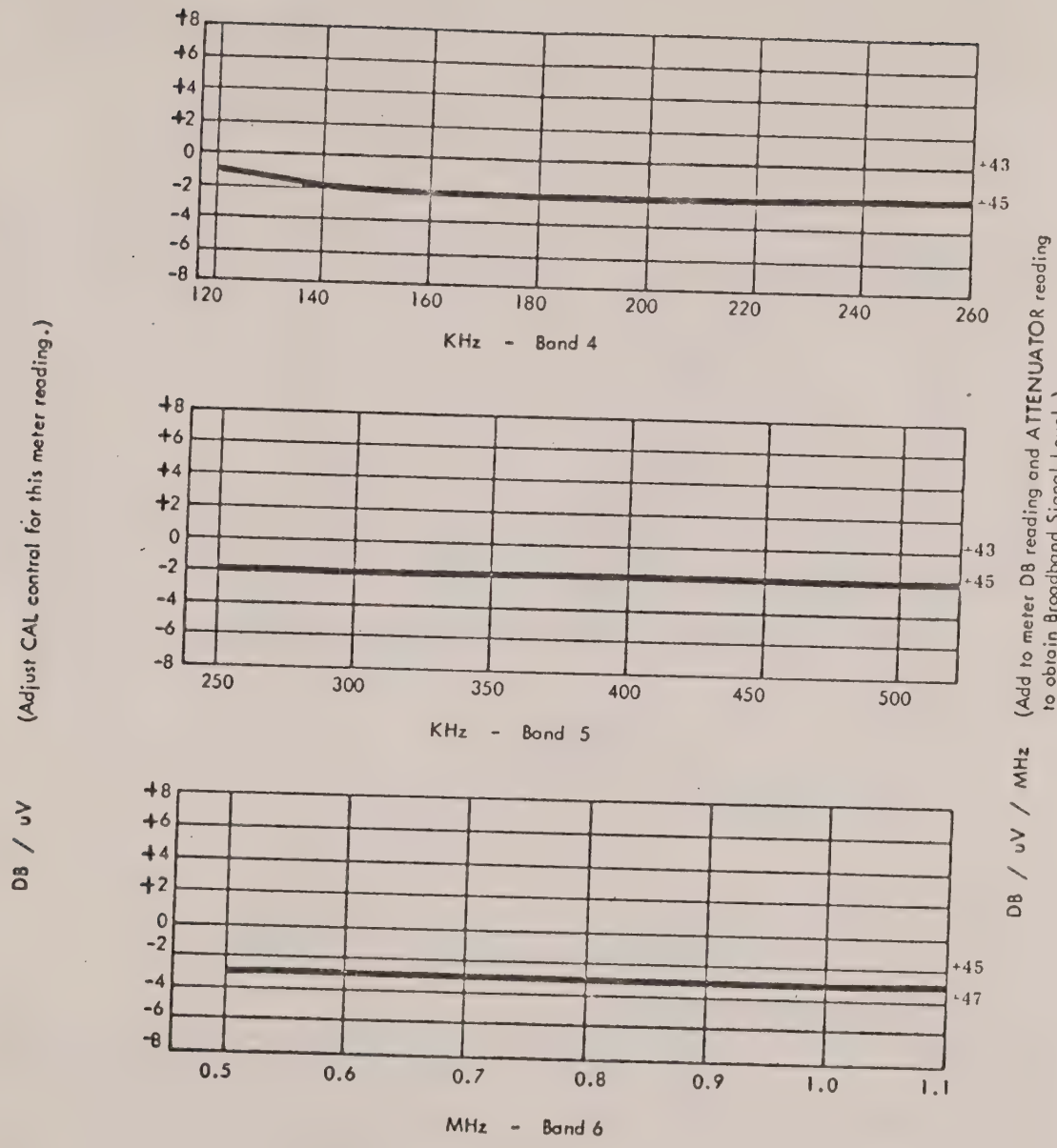


Figure 3.2 Typical Calibration Chart - Broad and Narrow Band

microvolts or DB above one microvolt proceed as follows:

a) Set controls:
ATTENUATOR - CAL (20 DB on black scale)
FREQUENCY - As required
TUNING MODE - Manual
TUNING AID - Off
DETECTOR FUNCTION - Peak
BANDWIDTH - Wide
DUMP - Full CCW

NOTE

Proper operation of the impulse generator, utilized as the built-in calibration standard, requires that the EMC-25 be physically situated within 30° of horizontal. Also, when operating normally, a moderate amount of "bounce" in the meter reading of the calibration standard is to be expected. The operator visually must average the reading to set the level specified on the chart.

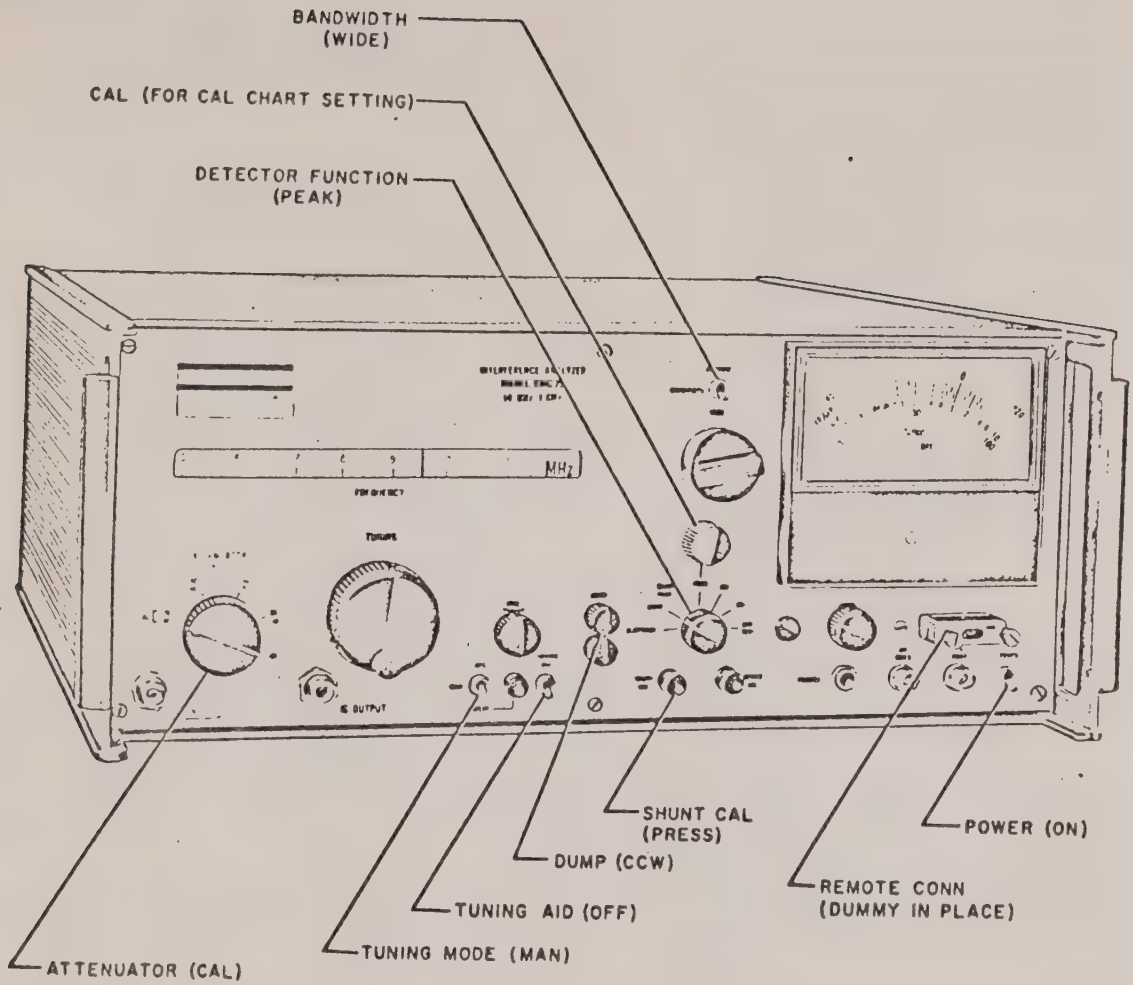


Figure 3.3 Control Settings for Calibration

b) Depress the SHUNT CAL button and simultaneously rotate the CAL knob until the meter indicates the DB value shown on the left-hand scale of the calibration chart. (Figure 3.2 is a typical chart.) (Proper settings are approximately 20 DB below full scale.)

c) The instrument is now calibrated. DB above one microvolt may now be read by algebraically adding the DB value shown on the meter to that indicated at the ATTENUATOR setting. The black values are used below 25 MHz (Bands 1-10) and the orange above 25 MHz (Bands 11-15).

For the bands covering up to 25 MHz (white frequency scale), microvolt values may be read directly from the meter when the attenuator is in the 0 DB position. Full scale values for the various attenuator positions (orange or black) are as follows:

ATTENUATOR	FULL SCALE VOLTAGE
0 (black only)	10 uv
20	100 uv
40	1 mv
60	10 mv
80	100 mv
100	1 v

d) Set the DETECTOR FUNCTION switch and ATTENUATOR as required by the signal being measured. The BANDWIDTH switch may be set to either Wide or Narrow, as required by the signal bandwidth or noise considerations.

3.7.3 BROADBAND CALIBRATION. To calibrate the EMC-25 for reading signal levels in DB above one microvolt per megahertz, proceed as follows:

a) Set controls:
ATTENUATOR - CAL (20 DB on black scale)
FREQUENCY - As required
TUNING MODE - Manual
TUNING AID - Off
DETECTOR - Peak
BANDWIDTH - Wide
DUMP - Full CCW

b) Depress the SHUNT CAL button and simultaneously rotate the CAL knob until the meter indicates the DB value shown on the left-hand scale of the calibration chart. (See note in paragraph 3.7.2.a.)

c) The instrument's gain is now set properly. To read signals in terms of DB-above-one-microvolt-per-megahertz, algebraically add the DB values on the right-hand scale of the calibration chart to the meter reading and those indicated around the ATTENUATOR. The black values are to be used below 25 MHz (bands 1-10) and the orange above 25 MHz (bands 11-15).

3.7.4 LARGE SIGNAL OPERATION

When measuring extremely large signals or fields it may not be possible to follow the calibration procedures of 3.7.2 and 3.7.3 due to leakage of the calibrator coaxial switch. If this condition is suspected do the following:

a) Turn the ATTENUATOR fully clockwise to the 100 DB (black) position regardless of frequency.

b) Perform step 3.7.2(b) or 3.7.3(b) as before, adjusting the CAL control for a meter reading 10 DB less than that shown on the left side of the calibration chart.

c) Signal levels may then be read exactly as described in 3.7.2 and 3.7.3. No additional corrections are needed.

3.8 ACCESSORY CONNECTIONS

A Connector Junction Box CJB-25 is furnished with the EMC-25R to enable the simultaneous use of several accessories. Connections must be made as follows:

a) Connect the 34 pin plug at the end of the short cable to the EMC-25 REMOTE jack.

b) Connect an Antenna Control Cable ACC-25 from the round MS style connector to RVR, RVA or ALR antenna if used.

c) To operate the EMC-25 one of the following must be connected to either of the two 34 pin jacks on the CJB-25:
A. Dummy Plug
B. RIM-25
~~C. EXY-125A~~ ERRATA, PG. 2
D. SPD-125

d) Simultaneous use of both 34 pin connectors is reserved for special applications.

3.9 OPERATIONAL PRECAUTIONS

3.9.1 DUMMY PLUG. Normal manual operation can be achieved only when the dummy multiple-pin connector furnished with the instrument is securely in place on the front panel, or as described in section 3.8.

3.9.2 INPUT VOLTAGE. Damage to the input attenuator may result if signals larger than 5 volts RMS are applied continuously. Pulse signals must be of less than 0.5 watt average power and 500 watts peak power.

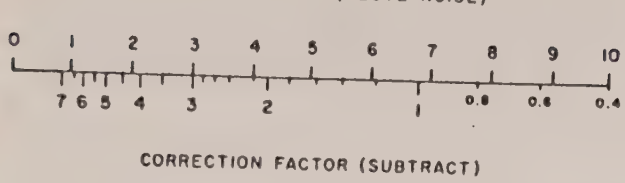
3.9.3 OFF FREQUENCY SIGNALS. Any superhet receiver such as the EMC-25 generates spurious signals when one or more high-level signals are applied to its input. The exact amplitude of the resultant signal is dependent on so many variables that specific prediction is not feasible.

Despite the many design precautions taken to minimize such responses, they will appear under some conditions. One method of determining whether a signal is spurious or not is to increase the input attenuation by 20 DB and note which signals drop by that amount. Any signals decreasing by more or less than 20 DB are spurious. The SPD-125 Specturm Analyzer accessory is a useful aid in this regard.

3.9.4 AUDIO OUTPUT. Use of low-impedance earphones or of a resistive load of less than 600 ohms will result in poor frequency response, distortion, and low power output.

3.9.5 TUNING ACCURACY. Stated tuning accuracy is met with the FINE TUNE control at mid-rotation. The FINE TUNE control is intended only for tuning narrow-band signals in the high frequency range and to compensate for discriminator offset when using AFC.

3.9.6 AMPLITUDE ACCURACY, For signals close to the noise level of the instrument, a correction must be made. Use the Correction Factor Scale on the next page.



Top Scale is that increase in DB in meter reading over noise level when input signal is applied.

Bottom Scale is that amount in DB to be subtracted from total meter reading to find actual signal level.

EXAMPLE:

Internal Noise	-30 DB (above 1 uV)
Meter indication with signal applied	-25 DB
Increase in meter reading (30-25)	5 DB
From scale: amount to be subtracted	1.65 DB

Actual signal level equals:

(-25) - 1.65 = -26.65 DB (above 1 uV)

The EMC-25 cannot be satisfactorily calibrated when the TUNING AID or AFC are in operation. Carriers can be measured with AFC on only if the signal has been peaked on the meter using the FINE TUNE control. The TUNING AID must be off while measuring amplitude.

3.10 CONTROL FUNCTIONS (Figure 3.4)

3.10.1 ATTENUATOR. The attenuator addes attenuation to the RF and IF circuits in 20 DB increments. The black numbers are added to the meter reading to obtain the proper scale multiplier below 25 MHz. The orange backed numbers are used above 25 MHz.

3.10.2 TUNING. The main manual frequency control for the instrument causes the cursor of the Frequency dial to move and indicate the frequency to which the instrument is tuned.

3.10.3 FINE TUNING. A vernier control covering approximately one percent of a band is used to facilitate tuning of narrow-band signals and is especially useful on the higher bands.

3.10.4 TUNING MODE. A three-position selector switch which determines whether tuning is to be done manually without AFC, manually with AFC, or whether the internal sweep circuit is energized.

3.10.5 SWEEP START. Resets the internal sweep circuit to the low end of the band. Upon its release the receiver sweeps upward in frequency linearly with time, reaching the upper

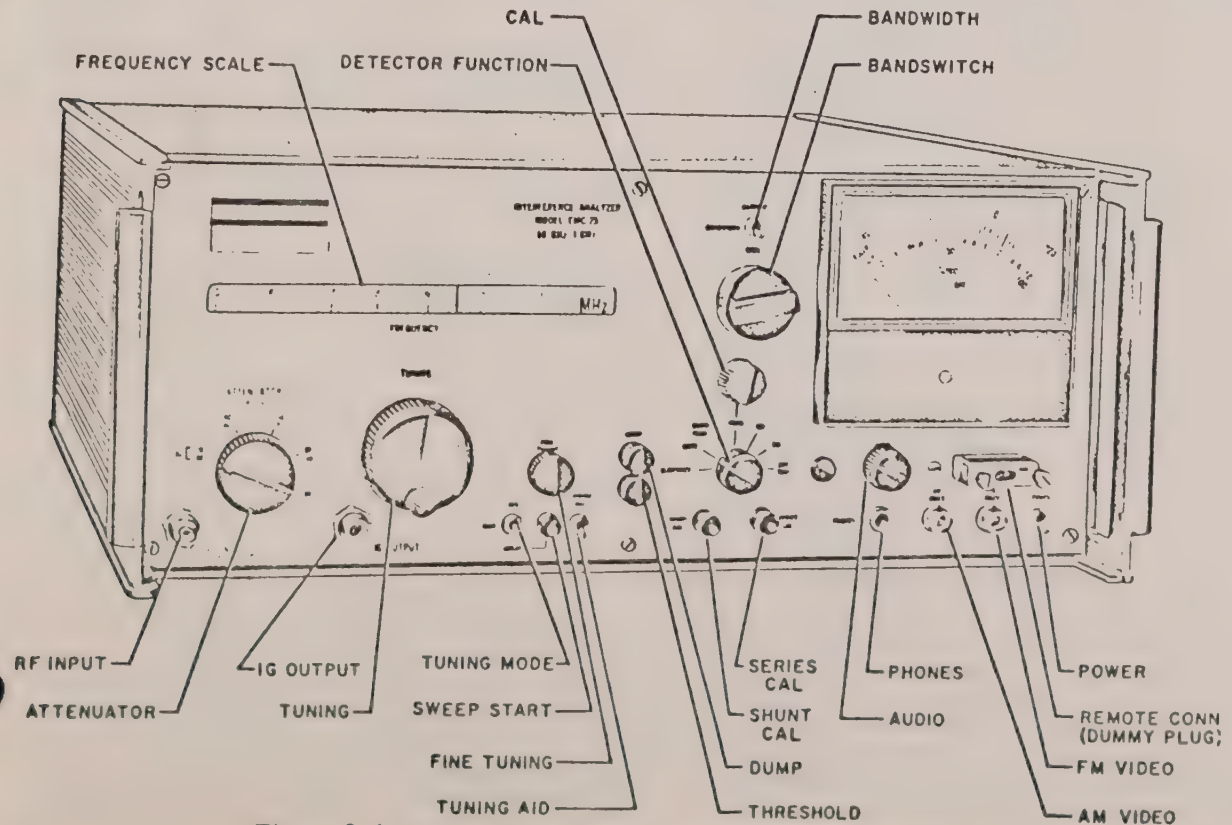


Figure 3.4 EMC-25 Front Panel Connectors and Controls

band limit in approximately one minute. The X-output voltage available at the Remote Connector also varies in accordance with the frequency sweep.

3.10.6 TUNING AID. Used to aurally locate weak unmodulated signals.

3.10.7 SHUNT CAL. Activates the impulse generator calibrator and connects it to the receiver input.

3.10.8 SERIES CAL. Activates the impulse generator calibrator and connects it to the IG OUTPUT jack.

3.10.9 DETECTOR FUNCTION. Determines the detector time constant and switches the meter to read either detector output or modulation level.

3.10.10 DUMP. Adjusts the length of time the detector "holds" a signal level when the Detector Function switch is in the "Peak" mode. Extreme counter-clockwise rotation deactivates the "dump" circuit resulting in normal peak detection.

3.10.11 THRESHOLD. Adjusts the aural extinction point when the Detector Function switch is in the "Slideback" mode.

3.10.12 AUDIO. Adjusts the audio output level at the phone jack and the reference level for the "AM" and "FM" Modulation positions of the Detector Function switch.

3.10.13 BANDSWITCH. Manually switches the desired band into position.

3.10.14 BANDWIDTH. Switches the receiver to either the wide or narrow bandwidth with respective values specified for the frequency band selected.

3.10.15 CAL. Adjusts the receiver gain to permit amplitude calibration.

3.10.16 POWER. Used to place the instrument in operation.

3.11 DETECTOR FUNCTIONS

3.11.1 GENERAL. Careful use of the DETECTOR FUNCTION switch, BANDWIDTH switch and associated controls can yield much information about the type of signal being received. Some functions are useful only for manual use while others can be used both manually and automatically.

3.11.2 SLIDEBACK. Having performed the Broadband Calibration (paragraph 3.7.3), very weak signals or adjacent signals having different repetition rates may be measured aurally using the slideback function.

a) Calibrate according to 3.7.3.
b) Turn the ATTENUATOR to obtain a reading "on scale".
c) Plug in PHONES. Turn AUDIO CW. Turn THRESHOLD CW.
d) Adjust AUDIO so that background hiss can barely be heard.
e) Adjust THRESHOLD until peaks of the signal being measured are heard, then turn CW slowly until they just become inaudible.
f) Read meter and add correction factors as in paragraph 3.7.3.c.

Alternately, if an external variable broadband signal source is available, it can be substituted for the unknown signal to determine its amplitude.

3.11.3 CARRIER. In the CARRIER position, the meter indicates the RMS value of the carrier with all modulation stripped off by the meter's time constant. When using this position it should be remembered that high peak signal levels might overload the EMC-25 and result in erroneous readings. If the DETECTOR FUNCTION switch is first placed in PEAK and the ATTENUATOR adjusted so that full scale meter deflection is not exceeded, the CARRIER function can then be used with assurance that overload will not occur.

3.11.4 QUASI-PEAK. In the QUASI-PEAK position, the metering circuitry provides a 1 millisecond charge time constant and a 600 millisecond discharge time constant over the entire meter scale. Since vacuum-tube-type instruments typically do not have the same time constants over the entire metering range, measurements among various such instruments will not agree. Similarly, Quasi-Peak measurements made with the EMC-25 probably will not agree at all levels with those made on a measuring set with vacuum tube circuitry.

3.11.5 PEAK. The PEAK measurement circuit has a rise time much shorter than the reciprocal of the IF amplifier bandwidth. Fall time is greater than 10 seconds with the DUMP control fully counterclockwise (the normal position for manual operation). The PEAK circuit is calibrated in terms of the RMS value of an unmodulated carrier and should read the same as CARRIER for unmodulated signals. Pulsed RF signals will be read as the RMS value of the carrier at the peak of the modulation. There

are no significant low repetition rate errors until the rate is below one pulse per second. Pulse response is also altered by the IF bandwidth and its near-gaussian characteristic.

3.11.6 AM MODULATION. The detector is turned into a video voltmeter in the AM Modulation position so that a variety of measurements of the amplitude modulation of carriers can be made. The 0 to 100 percent scale used for modulation measurements is linear and the 3 DB-down, frequency response points are below 20 Hz and above 16 KHz. However, the BANDWIDTH control can further narrow the audio bandwidth. See Section 3.14 for operating instructions.

There is no internal calibrator for the modulation functions. An external sine wave modulated signal of known modulation percentage can be used to calibrate the percent scale if absolute measurements are desired. A fixed carrier level as indicated in the CARR position must be maintained to obtain meaningful percent readings. The AUDIO control adjusts the gain of the metering circuit.

3.11.7 FM MODULATION. The FM MODULATION position permits metering the output of the built-in discriminator. The metering detector is AC-coupled with 3 DB-down frequency response points below 20 Hz and above 16 KHz. Its gain is set with the AUDIO control and output is read on the meter's percent scale.

Because percent modulation has no general meaning for FM or PM signals, calibration must be performed using a signal of known deviation. Full limiting is achieved with any signal that indicates on the upper meter scale in the CARR position. The signal should be carefully tuned for maximum meter indication in the CARR position and the proper IF BANDWIDTH used or severe phase distortion can occur. AFC may be used to "hold" drifting signals, as outlined in Section 3.12.

3.12 AFC OPERATION

Accurate CARR, AM and FM MODULATION measurements of drifting signals can be made if the AFC circuit is used. To properly use the AFC:

a) Set controls:
DETECTOR FUNCTION - CARR.
BANDWIDTH - As desired
TUNING MODE - MAN.

b) Using the TUNING and FINE TUNING controls, tune the signal for maximum meter indication.

c) Turn the TUNING MODE switch to AFC and repeak the signal with the FINE TUNE control.

3.13 TUNING AID OPERATION

Location of extremely weak signals is enhanced by use of the TUNING AID. With the TUNING AID on, a "beat note" will be heard when tuning past a signal. The TUNING AID switch should be off (down) while making all quantitative measurements, or serious inaccuracies will result.

3.14 BANDWIDTH CONTROL

A variation of at least 6:1 in 3 DB CW bandwidth is selectable with the BANDWIDTH control. The available bandwidths, which vary with the band in use, are shown in Section 1.3.

Maximum CW sensitivity is obtained in the NARROW bandwidth, but if it is desired to recover the signal's modulation the bandwidth should be chosen carefully, consistent with the width of modulation.

Maximum impulse sensitivity is obtained in the WIDE bandwidth, for which all calibration curves are given. Determination of whether a signal is broadband or narrowband can be made by setting the Detector Function switch to Peak, the Bandwidth to WIDE and tuning in the signal. Note the meter indication and switch to NARROW. Compare the drop in meter indication with that noted when switching from WIDE to NARROW using the internal impulse generator (see paragraph 3.7.3 for control settings). If the drop on the external signal is less than that using the impulse generator, by a margin of at least 2 DB, the signal is narrow compared to the wide bandwidth of the EMC-25 and cannot be accurately measured in terms of DB/uV/KHz (or MHz).

3.15 CONNECTOR FUNCTIONS - FRONT PANEL

3.15.1 RF INPUT. The nominal 50-ohm input terminal to which the signal to be measured is applied.

3.15.2 IG OUTPUT. The output terminal of the impulse generator.

3.15.3 PHONES. The terminal for 600 ohm or higher impedance earphones.

3.15.4 AM VIDEO. A nominal 91-ohm output terminal for DC-coupled, logged, signal amplitude video information.

3.15.5 FM VIDEO. A nominal 91-ohm output terminal for DC-coupled, instantaneous FM deviation video information.

3.15.6 REMOTE CONNECTOR. The interface connector for all system remote control functions.

3.16 CONNECTOR FUNCTIONS - REAR PANEL (See Figure 3.5)

3.16.1 PRE-IF OUTPUT. Provides a linear signal at one of the three IF frequencies depending upon the band in use. Impedance is nominally 50 ohms. Voltage level and bandwidth depend on the band in use. This output should be capped when unused and terminated in 50 ohms during use.

3.16.2 POST-IF OUTPUT. Provides a linear signal at the IF frequency and selected bandwidth determined by the band in use and position of the BANDWIDTH switch. 1 MV is available at 8.7 MHz and 3 MV at 175 KHz and 1.6 MHz for full scale meter reflection. This output should be capped when unused and terminated in 50 ohms when in use.

3.16.3 POWER INPUT. Either AC power or an external battery may be connected here, to charge or supplement the internal battery.

3.17 BATTERY OPERATION

To operate the EMC-25 on internal battery turn on the POWER switch. Immediately push the BAT TEST button. Observe the indicator, i the BAT TEST light glows, then the instrumen may be put into use. Never leave the POWER switch on for more than a few seconds, if the light does not glow, or the battery may be damaged. It is advisable to check the battery condition periodically during extended use.

A fully charged battery will operate the EMC-25 for at least eight hours. Use of the band-stepping motor in the EMC-25R will shorten the operating cycle moderately, the exact amount depending on the duty cycle of its use. The instrument should not be stored with a discharged battery longer than one week. During long storage periods, the battery should be brought to full charge at least once every six months.

3.17.1 CHARGING THE BATTERY. The internal battery is charged any time the instrument is connected to an AC line. It takes approximately 16 hours to fully charge a completely discharged battery.

To charge the battery, set the line voltage switch on the rear panel to the appropriate position, change the adjacent fuse to the correct value if necessary and connect the line cord

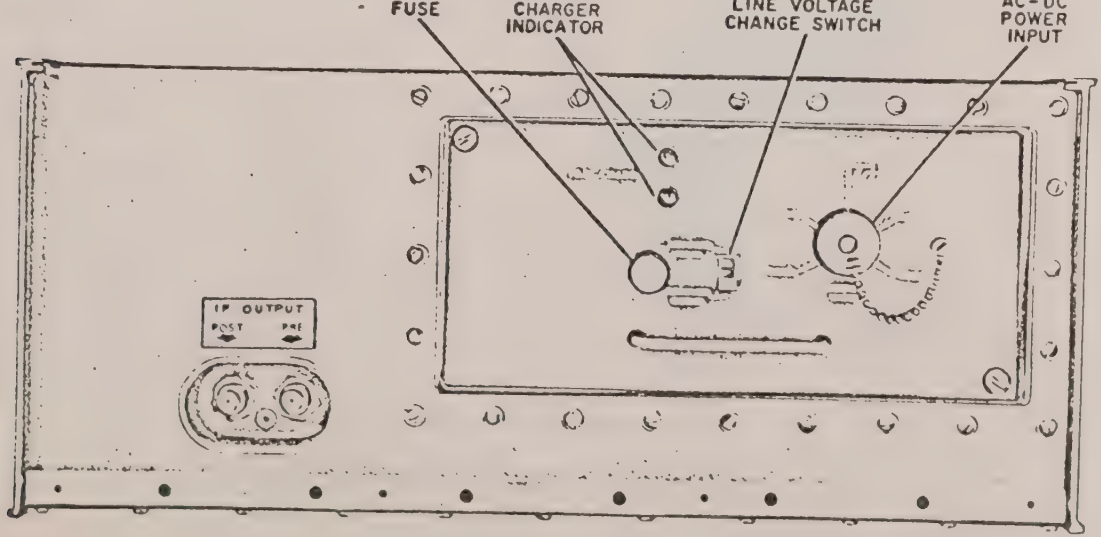


Figure 3.5 Connector Functions, Rear Panel

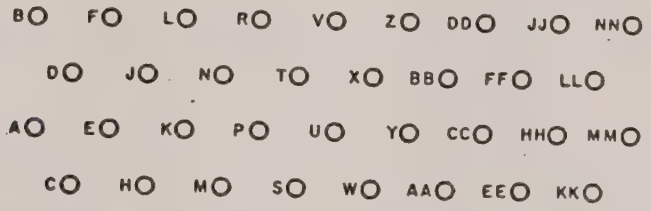
PCD-25. The two pilot lights will glow, indicating that the charger is operating. The POWER switch should be left off to obtain the maximum charge rate.

3.18 LINE OPERATION

To operate the instrument from an AC line adjust the line voltage switch and fuse as outlined in paragraph 3.17.1 before connecting the PCD-25 line cord, then turn the POWER switch on and immediately check the battery charge. Do not leave the POWER switch on if the BAT TEST light does not glow. The battery must first be charged as described in paragraph 3.17.1, despite the AC power source.

3.19 EXTERNAL BATTERY

Battery operation for periods longer than 8 hours may be accomplished by using external storage batteries in conjunction with power cord PDD-25. To operate, connect an external floating battery of 30 to 56 volts utilizing the PDD-25. The red clip should be connected to the positive battery terminal. Turn on the POWER switch and check the battery as outlined in 3.17. The same precautions apply. The instrument will only draw power from the external battery (as indicated by the charge lights) if the external battery is more than 6.5 volts higher than the internal battery.



A	Tuning Pot Arm
B	Sweep In
C	Tuning Voltage Input (0 to +1.5 v nominal)
D	Sweep Out
E	4-Band Logic
F	1-Band Logic
H	8-Band Logic
J	2-Band Logic
K	AFC
L	BW Selector Out
M	Band Logic Comm.
N	BW Command (+12 v = N.B. -6 v = W.B.)
P	0.1NB COMMAND (+12v=0.1NB; OPEN=NB,WB
R	Y Out (1 ma. 1500 ohms)
S	NC X-Y Recorder Pen Lift
T	Comm. X-Y Recorder Pen Lift
U	Audio Output
V	X Out (0 to +1.5 v)
W	Step Command (0 = OFF + 12 v = STEP)
X	Shunt Cal Command (- Raw Activate)
Y	IG Contacts (-300 v to +300 v for external level)
Z	IG Driver Command (-6 v)
AA	Gain (0 to +12 v)
BB	Dump Command
CC	Ground
DD	HV Raw
EE	+12 v Command Functions Only
FF	Ground
HH	Internal IG Level Switch
JJ	-6 v Command Functions Only
KK	+Raw Command Functions Only
LL	Spare
MM	Spare
NN	-Raw Command Functions Only

Figure 3.6 Remote Connector (Outside View)

TABLE 3-1

REMOTE FUNCTIONS

FIGURE	FUNCTION
3.7	Connections necessary for manual operation
3.8	Connections necessary for X-Y recorder monitoring
3.9	Connections necessary for audio monitoring
3.10	Connections necessary for remote tuning
3.11	Connections necessary for remote gain control
3.12	Connections necessary for remote tuning meter.
3.13	Connections necessary for external meter/recorder monitoring
3.14	Connections necessary for remote bandwidth operation
3.15	Connections necessary for remote external sweep control

3.20 REMOTE OPERATION

3.20.1 PROGRAMMING. Remote programming of the EMC-25 is achieved through the REMOTE connector by either voltage or resistance control. Figure 3.6 illustrates the REMOTE connector with the lettering corresponding to each input and the legend denotes each pin function. Figure 3.7 shows the connections necessary to the dummy connector for manual operation. Figures 3.8 through 3.16 show connections necessary for remote programming of various functions that may be desirable depending on the test setup used. Table 3-1 lists each hookup, relates it to the proper figure and gives its function. Appropriate notes are contained in each figure.

3.21 X-Y PLOTTING

3.21.1 GENERAL. With the addition of an X-Y Plotter, such as Electro-Metrics Model EXY-125A, the internal sweep circuit can be used to make semi-automatic measurements.

3.21.2 INTERNAL SWEEP. The EMC-25 is equipped with an internal one-minute linear sweep circuit. It is energized by switching the Tuning Mode switch to SWEEP and is reset to the low frequency end of the band in use by depressing the START push button. As it sweeps the EMC-25 from the low to the high frequency end of the band in use, a 0 to 1.5 volt sweep voltage simultaneously appears at the Remote Connector for attachment to the X axis of an X-Y Plotter. This sweep mode is generally

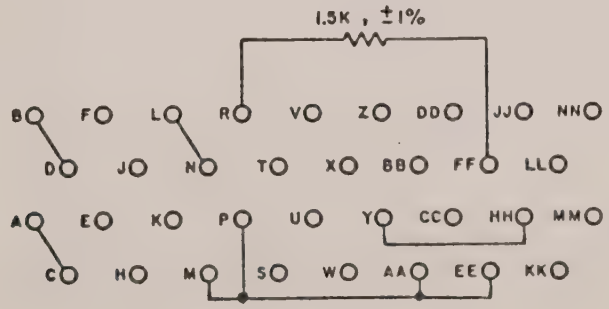


Figure 3.7 Remote Connector (Manual Operation)

used with the EXY-125A Plotter and its accompanying cable XYC-25. A connection diagram for other plotters is shown in Figure 3.8.

The internal sweep requires the use of the detector mode switch in PEAK and the DUMP control "on", but as far counter-clockwise as it can be turned without "clicking" the detent off. Calibration is accomplished as follows:

a) Leaving the Tuning Mode selector in MANUAL, tune the EMC-25 to the low frequency end of any band.
b) Adjust the plotter X-ZERO to bring the pen to the left hand margin of the paper.
c) Tune to the high frequency end of the band and adjust the X-GAIN control of the plotter to the right hand margin of the paper.
d) Repeat steps A thru C as required.
e) Adjust the plotter Y-ZERO until the noise reads slightly above the bottom margin.
f) Supply an impulse signal to the input of the EMC-25 from an external impulse generator or internally through the SHUNT CAL function of the CLC-25.
g) Adjust the IG level to make the EMC-25 meter read full scale.
h) Adjust the plotter Y-GAIN control to bring the pen to the top margin.
i) Place the Tuning Mode selector in the SWEEP position. Depress and release the START button. The EMC-25 will sweep across the chosen band in approximately one minute. The noise level and various IG levels may be plotted on the paper to provide calibration lines. If it is decided to recheck a signal after automatically scanning, the Tuning Mode switch should be moved back to MAN and the START button depressed to lift the plotter pen.

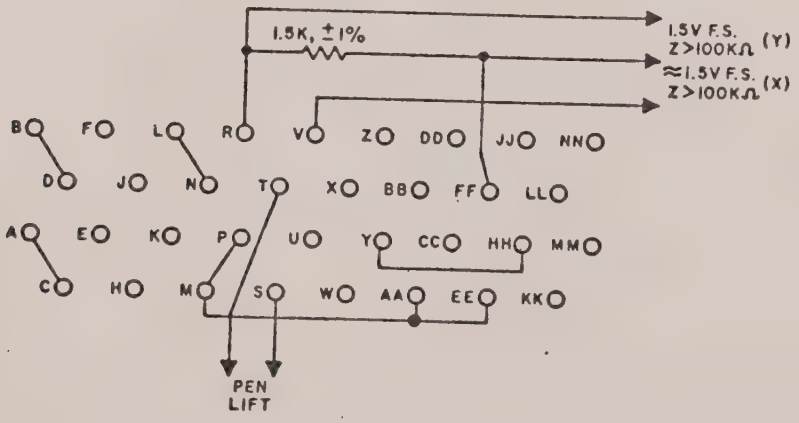


Figure 3.8 X-Y Plotter - Remote Connections

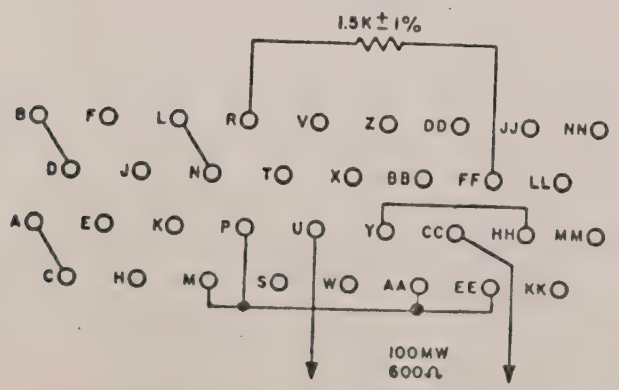


Figure 3.9 Audio - Remote Connections

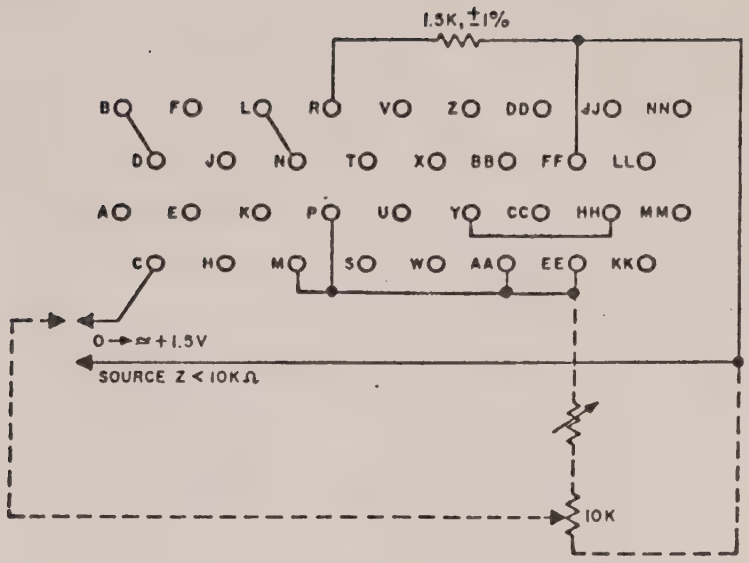


Figure 3.10 Tuning - Remote Connections

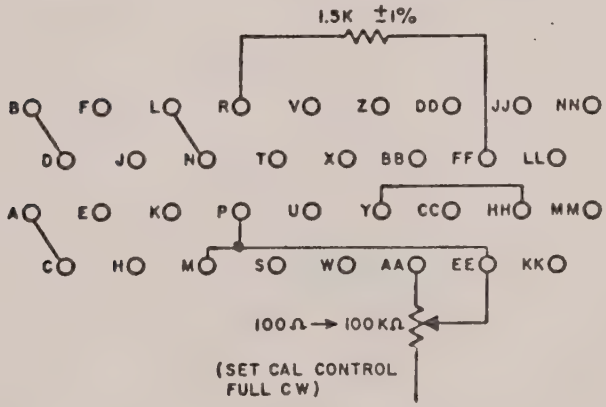


Figure 3.11 Gain - Remote Connections

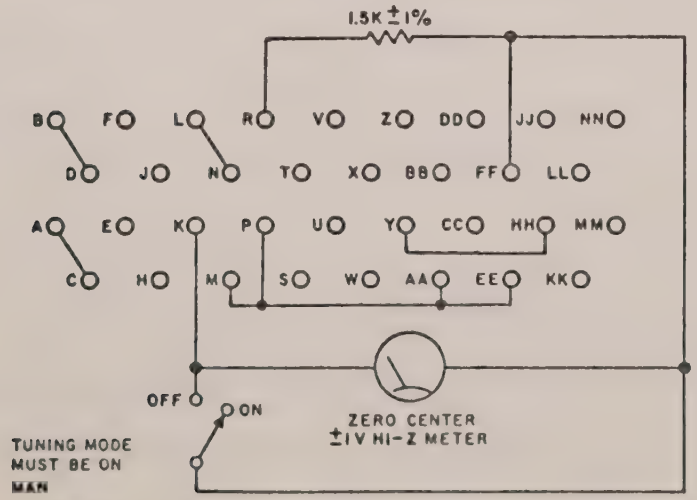


Figure 3.12 Tuning Meter - Remote Connections

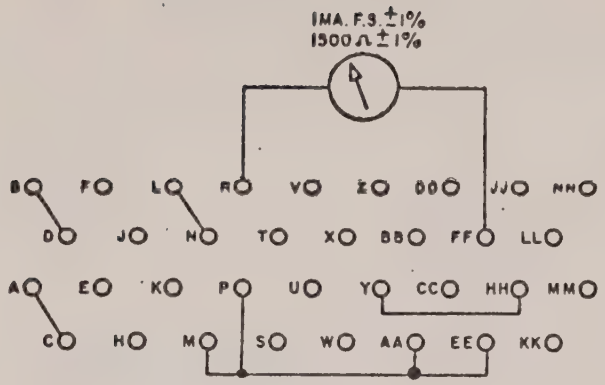


Figure 3.13 External Meter/Plotter - Remote Connections

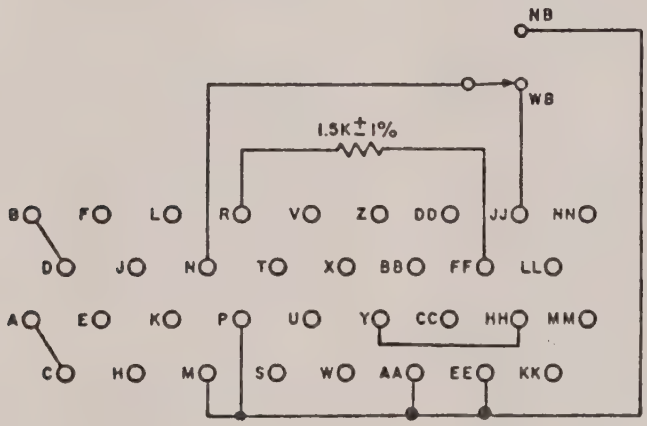
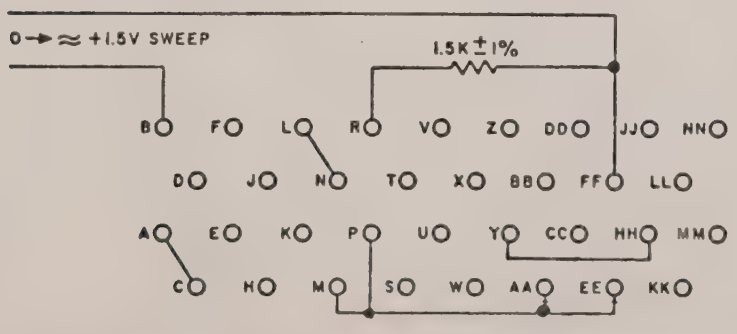


Figure 3.14 Bandwidth - Remote Connections



EXTERNAL SWEEP WILL BE ACTIVATED ONLY WHEN THE TUNING MODE SWITCH IS SET TO SWEEP. FOR MANUAL OPERATION, SET SWITCH TO MANUAL.

Figure 3.15 Manual Tune-External Sweep - Remote Connections

SECTION IV
PERFORMANCE CHECK-OUT

4.0 PERFORMANCE CHECK-OUT

4.1 GENERAL

The Performance Tests listed in this section are designed to give specific information as to the operational status of the instrument. The results of these tests will indicate whether the EMC-25 is performing within specification limits or not, and whether repair or recalibration is necessary. The results of these tests as an incoming inspection check should be recorded and used as a standard for further testing at every maintenance interval.

Tests for 4.4.2 & 3 VOLTAGE ACCURACY, 4.4.4 FREQUENCY ACCURACY, 4.4.6 CW SENSITIVITY, 4.4.7 IMPULSE SENSITIVITY, and 4.4.10 IMAGE REJECTION refer to 3 test frequencies per band. These tests shall be performed at the first and last indicated frequencies and at a frequency in the center of each of the 15 bands.

Table 4-1 lists recommended test equipment, required characteristics and when equipment is used.

4.2 WHEN TO TEST

The performance tests should be used:

a) As a part of the incoming inspection check with the results permanently recorded.

b) Periodically as a part of the maintenance check for every 2000 hrs. of use.

c) As a part of the repair procedure to locate malfunctioning circuits.

4.3. PERFORMANCE TESTING PROCEDURE

a) Unless otherwise specified in the test the front panel controls shall be set as follows:

ATTENUATOR	CAL (20 dB Black)
TUNING MODE	MAN
FINE TUNING	Mechanical Center
TUNING AID	OFF (down)
DUMP	OFF (fully CCW)
DETECTOR FUNCTION	PEAK
AUDIO	Fully CCW
BANDWIDTH	WB
POWER	ON (up)

b) The following tests may be performed in any sequence desired, however, it is recommended that they be performed in the order in which they are listed. To minimize time spent in band switching, tuning, etc. as many readings as possible should be taken while set to any given frequency.

4.4 ACCURACY AND PERFORMANCE TESTS

4.4.1 PRECAUTIONS

a) When making measurements such as the Voltage Accuracy Test, caution should be taken to avoid ground loops between AC operated equipment.

b) The proper source impedance must be presented to the instrument's input. Some Impulse Generators will work properly only if a pad is placed at their output.

c) Interconnecting cables should be of the shortest length possible or of known loss.

d) A 15 minute warm-up period for the EMC-25 should be allowed before beginning the tests.

e) The EMC-25 must be within 30^{o} of the horizontal position and right side up.

f) A DUMMY PLUG as furnished with the unit, must be connected to the front panel REMOTE connector for all tests.

g) A check of the BAT. TEST indicator on the front panel should be made to see if it lights before proceeding to test.

h) Some Impulse Generators are calibrated in terms of equivalent peak CW voltage while the majority are in terms of equivalent RMS voltage. It should be noted that a 3 dB difference exists between the two types and 3 dB must be subtracted from a peak voltage calibrated instrument's indicated output to obtain the equivalent RMS value. The EMC-25 is calibrated in terms of the equivalent RMS value of the peak signal for impulse signals.

i) Accuracy of the test equipment must be commensurate with that of the parameter being measured.

4.4.2 CW VOLTAGE ACCURACY

a) Depress and hold in the SHUNT CAL push-button switch. Rotate the CAL control to produce a front panel meter reading as indicated on the left-hand side of the Calibration Chart for the band and frequency undergoing test. Release the SHUNT CAL push-button. Rotate the DETECTOR FUNCTION switch to the CARR position.

b) Using a signal source with a 50 ohm output

TABLE 4-1 RECOMMENDED TEST EQUIPMENT

INSTRUMENT TYPE	REQUIRED CHARACTERISTICS	USE
Signal Generators HP-651 HP-608 HP-612	14 kHz - 1000 MHz Calibrated Attenuator .1uV to 1.0V output 14 kHz to 25 MHz .1uV to 0.1V output 25 MHz to 1 GHz Amplitude Accuracy ± 1 dB Frequency Accuracy (checked with Frequency Counter below) 50 ohms source impedance	Performance check-out Alignment Calibration
Impulse Generator Singer-IG-115	Calibrated 0 to +80 dB uV/MHz (with required padding)	Calibration Performance check-out
Step Attenuator EMC-SA-600	Calibrated 0-60 dB Accuracy ± 0.1 dB Referred to 0 dB Position	Performance check-out Calibration Alignment
Frequency Counter HP-5246 HP-5253 HP-5254	Calibrated 14 kHz - 1 GHz Accuracy ± 0.1%	Performance check-out Alignment Calibration
Digital Volt-Ohmmeter Fairchild-7050	3 1/2 Digits 1.5V to 1500V f.s. ± 0.1% + 1 Digit Accuracy	Alignment Repair
Video Voltmeter HP-400E	Average or RMS responding 10 MHz Frequency Response 10MV to 10V f.s. ± 2% Accuracy 1M ohm input impedance	Alignment Repair
Oscilloscope Tektronix-453	50MV to 10V f.s. DC coupled 10 MHz Frequency Response 1 sec to 0.1 u sec/CM time base	Alignment Repair

impedance tuned to the EMC-25 selected frequency, apply a signal to the RF INPUT jack of the proper amplitude, 10 uV for 14 kHz to 25 MHz and 100 uV for 25 MHz to 1 GHz. Record the difference between the actual meter reading and the proper reading of 0 dB.

c) Repeat steps a) and b) at 3 test frequencies on each band, 1-15. Voltage accuracy is ±1.5 dB in the top 20 dB of the meter scale at all frequencies.

4.4.3 BROADBAND VOLTAGE ACCURACY

a) Depress and hold in the SHUNT CAL push-button switch. Rotate the CAL control to produce a front panel meter reading as indicated on the left-hand side of the Calibration Chart for the band and frequency undergoing test. Release the SHUNT CAL push-button.

b) Using a calibrated Impulse Generator, apply a signal to the RF INPUT jack of the proper amplitude, 70 dB uV/MHz for bands 1-7 and 50 dB uV/MHz for bands 8-15.

c) Add the meter reading obtained to the factor given for the frequency under test on the right-hand side of the Calibration Chart and 20 dB for bands 1-10 or 40 dB for bands 11-15.

Example 1: Band 3, Chart +38 dB, Meter +12 dB

12 + 38 + 20 = 70 dB uV/MHz

Example 2: Band 12, Chart + 3 dB, Meter + 7 dB

7 + 3 + 40 = 50 dB uV/MHz

Subtract the computed input level from the actual level supplied by the Impulse Generator to find the error. Voltage accuracy is ±1.5 dB in the top 20 dB of the meter scale at all frequencies.

4.4.4 FREQUENCY ACCURACY

a) With the BANDWIDTH switch in the NB position, the DETECTOR FUNCTION switch in the "CARR" position and the CAL control set at approximately mechanical center, adjust the main TUNING knob on the EMC-25 so that the cursor is exactly on each of the 3 test frequencies per band, being careful to view the scale straight-on to eliminate parallax.

b) Adjust the frequency of the signal source to the vicinity of the test frequency and sets its level for a meter reading of approximately "0" dB.

c) Carefully adjust the frequency of the signal source for a peak indication on the EMC-25 front panel meter. Frequency accuracy specification is ±2% of the indicated frequency (with the FINE TUNE control at its mechanical center).

d) Perform steps a) through c) for 3 test frequencies on each band, 1-15.

4.4.5 ATTENUATOR ACCURACY

a) With the ATTENUATOR in the 40 dB (black) position, the DETECTOR FUNCTION switch in the CARR position, and the TUNING set to the approximate center of band 6, apply a 100 uV CW signal. Adjust the signal generator for a peak indication on the meter and adjust the CAL control for 0 dB on the meter.

b) Change the signal source attenuator in 20 dB steps while changing the EMC-25 ATTENUATOR accordingly. Record the difference between the actual meter readings and the 0 dB mark. Specification for ATTENUATOR accuracy is ±1 dB.

c) Repeat steps a) and b) on Band 8 and on Band 11 changing the input level to 1 MV on Band 11.

4.4.6 CW SENSITIVITY

a) With the ATTENUATOR in the "0" dB position, BANDWIDTH switch in the NARROW position and the DETECTOR FUNCTION switch in the CARR position, apply a 10 uV signal for the 3 test frequencies on bands 1-10 and adjust the CAL control for a full scale meter indication.

b) Disconnect the generator, terminate the EMC-25 RF INPUT with a 50 ohm load, and read the residual noise indicated on the meter. Since residual noise equals tangential sensitivity, record this reading. Sensitivity specifications may be obtained from Section I.

c) Apply a 100 uV signal and adjust the "CAL" control for a full scale meter indication for the 3 test frequencies on bands 11-15.

d) Disconnect the generator and record the sensitivity as discussed in step b.

4.4.7 IMPULSE SENSITIVITY

a) With the ATTENUATOR in the 0 dB position, apply an impulse signal to the RF INPUT, increasing the level until the meter reads 3 dB above the residual noise.

b) The level applied by the generator is the impulse sensitivity. Sensitivity specifications may be obtained from Section I.

c) Follow this procedure at the three test frequencies for all bands, 1-15.

4.4.8 BANDWIDTH

a) With the DETECTOR FUNCTION in the CARR position, tune the EMC-25 to a midrange frequency on band 6 and adjust the CAL control for "0" dB on the meter with 100 uV input from a signal generator.

b) Increase the signal generator output by 3 dB on the EMC-25 meter and increase the frequency of the generator until the meter again reads "0" dB. Note and record the frequency of the generator.

c) With the same output level as in step b, decrease the frequency of the generator until the meter again reads "0" dB. Note and record the frequency of the generator. The difference between the two recorded frequencies is the 3 dB IF wideband bandwidth at that frequency. Bandwidth specification may be obtained from Section I.

d) Repeat the steps a) through c) for Band 8 at a frequency in the center of the band.

e) Increase the generator output to 1 MV and repeat the procedure on band 11 at a frequency in the center of the band.

f) Change the BANDWIDTH switch to the NB position and repeat steps a) through e).

g) Change the BANDWIDTH switch to 0.1 NB position (if the EMC-25 has the N OPTION included) and repeat steps a) through e).

4.4.9 METER TRACKING AND DYNAMIC RANGE

a) With the ATTENUATOR selector in the 40 dB (black) position, the DETECTOR FUNCTION switch in the CARR position, the BANDWIDTH switch in the NB position and at a frequency in the center of Band 6 apply a 100 uV CW signal from a signal generator. Adjust the signal generator for a peak indication on the EMC-25 meter and adjust the CAL control for 0 dB on the meter.

b) Decrease the original signal to the EMC-25 by 20 dB and note that the meter reading has dropped to -20 dB, within a ±2 dB specification.

c) Increase the original signal to the EMC-25 by 20 dB and note the meter reads full scale ±1.5 dB.

d) Repeat the above procedure at a frequency in the center of band 8.

e) Increase the generator output of 1 MV and repeat steps a) through c) at a frequency in the center of band 11.

4.4.10 IMAGE REJECTION

a) With the ATTENUATOR in the 40 dB (black) position, the BANDWIDTH switch in the NB position, and the DETECTOR FUNCTION switch in the CARR position, apply a CW signal level of 1 MV at each of the 3 test frequencies on each band, 1-10, and tune the generator for a peak indication on the meter.

b) Adjust the CAL control for full scale indication on the meter.

c) Tune the generator to two times the IF frequency plus the EMC-25 indicated frequency.

Example: Band 1, 14 kHz
2 (175 kHz) + (14 kHz) = 364 kHz = Image Frequency

d) Increase the generator output by 30 dB and tune the generator for a peak indication on the EMC-25 meter.

e) Record the difference between full scale and the meter reading from step d), adding 30 dB; this is the Image Rejection. Specification for Image Rejection is 45 dB minimum.

f) Repeat steps a) through e) for bands 11-15, except increase the signal output to 10 MV for a full scale indication at 3 test frequencies for each band. See Table 2-2 for first and second IF frequencies for each band.

4.4.11 IF REJECTION

a) With the ATTEN selection in the 40 dB (black) position, the BANDWIDTH switch in the NB position, and the DETECTOR FUNCTION switch in the CARR position, inject a signal level of 1 MV at a frequency in the center of each band, 1-10 and tune the generator for a peak indication on the EMC-25 meter.

b) Adjust the CAL control for a full scale deflection on the meter.

c) Tune the generator to the first IF frequency and increase the generator output by 30 dB.

d) Tune the frequency of the signal generator for maximum meter deflection.

e) Record the difference between full scale and the meter reading from step d, adding 30 dB; this is IF Rejection. Specification for IF Rejection is 45 dB minimum.

f) Repeat the steps a) through e) for bands 11-15 except increase the signal output at the frequencies for bands 11-15 to 10 MV for full scale indication.

g) Repeat steps a) through e) for the second IF frequencies of bands 4, 13, 14, 15, and record the data.

4.4.12 SPURIOUS RESPONSE

a) Place the ATTENUATOR switch in the fully CCW (0 dB) position, the DETECTOR FUNCTION switch to the CARR position, and the BANDWIDTH to NB position.

b) With all input signals disconnected, slowly tune the EMC-25 through each entire band observing and recording the frequency of any on-scale responses.

4.4.13 SWEEP

a) Select Band 6 and rotate the TUNING control so that the cursor moves to the 1.1 MHz frequency mark. Tune the signal generator for a peak response on the meter and adjust its level to obtain a full scale meter response.

c) Switch the TUNING MODE switch to the SWEEP position, depress the SWEEP start button, and note the time which elapses from the release of the button until the meter indicates a full scale response to the applied signal. The elapsed time should be 60 ±15 seconds.

TABLE 4-3 (cont'd)

RECOMMENDED SPARE PARTS LIST

FOR

INTERFERENCE ANALYZERS MODELS EMC-25 and EMC-25R

DESCRIPTION	RECOMMENDED QUANTITY 1 set/10 sets		PART NO.
Semiconductors	1	2	SE5020
Semiconductors	2	4	2N3693
Semiconductors	1	2	FD600
Semiconductors	1	2	2N3646
Semiconductors, matched pair	1	1	2N3690
Semiconductors	2	5	1N270
Semiconductors, matched pair	1	1	2N4065
Semiconductors, matched pair	1	1	2N3277
Semiconductors	1	1	SP8412A
Semiconductors	1	2	FD300
Semiconductors	1	1	2N3114
Semiconductors	1	1	2N3503
Semiconductors	1	2	2N1538 or 2N2137
Semiconductors	1	2	2N3054
Semiconductors	1	1	1N971B
Semiconductors	1	1	1N966B
Semiconductors	1	2	2N3273
Semiconductors	1	4	2A100
Semiconductors	1	1	1N752
Semiconductors	1	4	CER69C
Semiconductors	1	1	1N756
Semiconductors	1	1	1N825A
Semiconductors	1	1	2N3440
Semiconductors	1	1	2N4888
Semiconductors	1	1	1N986B

TABLE 4-3 (cont'd)

RECOMMENDED SPARE PARTS LIST

FOR

INTERFERENCE ANALYZERS MODELS EMC-25 and EMC-25R

DESCRIPTION	RECOMMENDED QUANTITY 1 set/10 sets		PART NO.
Semiconductors	1	2	91428
Semiconductors	1	2	2N3638
Semiconductors, 235 PF	1	2	PQ1005
Choke, 1 MH	2	5	210.000M
Choke, 330 MH	2	5	43,400M
Choke, 100 MH	2	5	21000M
Pot, 2 K	1	1	200S1-202
Pot, 200 ohm	1	1	150-1
Pot, 5 K	1	1	100-1
Pot, 100K	1	2	GSIN156 P104VA
Pot, 100K	1	2	GA2N156 P104VA
Pot, 2K	1	3	3067P1-202
Pot, 10K	1	2	7221 Helipot
Pot, 100K	1	3	JA3G048 P104UA
Pot, 10K	1	2	JA1G048 P103UA
Pot, 20K	1	1	30671P1-203
Pot, 500 ohm	1	1	3067P1-501
Pot, 500 K	1	1	3068P1-204
Capacitor, 2.2 MF	2	10	TSD-1-15-225
Capacitor, .01 MF 100V Disc	2	10	TTD
Capacitor, 1000 PF Feed thru	1	3	FB-2B
Capacitor, 5-25 PF Trimmer	2	10	557000-COPO-39R
Capacitor, 7-25 PF Trimmer	2	10	538-002-93R

TABLE 4-3 (cont'd)

RECOMMENDED SPARE PARTS LIST

FOR

INTERFERENCE ANALYZERS MODELS EMC-25 and EMC-25R

DESCRIPTION	RECOMMENDED QUANTITY 1 set/10 sets		PART NO.
Capacitor, 2-8 PF Trimmer	2	4	538-011-89R
Capacitor, 1000 MF	2	10	FA5C
Capacitor, .15 MF	2	5	C280AA-1-D150K
Capacitor, 15 MF	2	5	CS-13
Capacitor, 50 MF	1	1	NLW-50-25
Capacitor, 300 MF 150V	1	1	BR300-150
Switch,3 wafers	1	1	B3073-1,2,3
Switch	1	1	C3242
Switch,Push button	2	5	MSP-205R
Switch,Toggle	1	1	MST-205PA
Switch,Toggle	1	2	MST-205N
Switch,Rotary	1	1	B3246-1,2,3
Switch,Line	0	1	G326
Switch,Micro	1	3	E62 10.1A 250VAC
Crystal,1.425 MHz	0	1	CR-18/U
Precision Resistor, 40.2 ohm 1/4W 1%	1	1	RN60D
Precision Resistor, 820 ohm 1/4W 2%	1	1	RG07
Precision Resistor, 180 ohm 1/4W 2%	1	1	RG07
Precision Resistor, 270 ohm 1/4W 2%	1	1	RG07
Precision Resistor, 1.5K 1/4W 1%	1	1	RN60D
Precision Resistor, 82.5K 1/8W 1%	0	1	RN60C
Precision Resistor, 97.6K 1/8W 1%	0	1	RN60C
Precision Resistor, 12.1K 1/8W 1%	0	1	RN60C
Precision Resistor, 2.94K 1/8W 1%	0	1	RN60C
Precision Resistor, 2.26K 1/8W 1%	0	1	RN60C

TABLE 4-3 (cont'd)

RECOMMENDED SPARE PARTS LIST

FOR

INTERFERENCE ANALYZERS MODELS EMC-25 and EMC-25R

DESCRIPTION	RECOMMENDED QUANTITY 1 set/10 sets		PART NO.
Precision Resistor, 1.24K 1/8W 1%	0	1	RN60C
Precision Resistor, 2.05K 1/8W 1%	0	1	RN60C
Precision Resistor, 76.5K 1/8W 1%	0	1	RN60C
Precision Resistor, 76.6K 1/8W 1%	0	1	RN60C
Precision Resistor, 57.6K 1/8W 1%	0	1	RN60C
Precision Resistor, 35.7K 1/8W 1%	0	1	RN60C
Jack, Phone	0	1	111, A-1-05AX
Jack, Video	1	2	UG625/U
Jack, Female	1	1	SRE-34-S-J
Jack, Dummy Plug	1	2	SRE-34-PFTCH-8
Cell, Battery	1	3	B3260
Circuit Breaker	1	2	MB315
Circuit Breaker, Battery	2	6	MB316
Connector, Power	1	1	MS3102 A14S-6P
Connector, Fanning Strip	0	1	11-160-CAL or 7-160 BAL
Connector, Male	0	1	27-9
Connector, Female	0	1	27-7
Crimp Tool for 27 Conn.	0	4	277-900
Cable, Battery with Connector (3128)	0	1	
Relay, Control, Motor Drive	1	2	842-0111-512-07
Relay, Clutch	0	1	FC130-101
Motor, Main Drive	1	2	3174
Step Switch	1	1	D-4242-1,2
Straps, IF Hold Down	0	2	3453
Shaft Coupling	1	1	3086
Bracket, Adapter	1	1	2273

TABLE 4-3 (cont'd)

RECOMMENDED SPARE PARTS LIST

FOR

INTERFERENCE ANALYZERS MODELS EMC-25 and EMC-25R

DESCRIPTION	RECOMMENDED QUANTITY 1 set/10 sets		PART NO.
Gasket 5'	1	1	1/8"
Assembly,Tuning Mech.	0	1	3401
22 pin connector PC Card	0	1	250-22-30-170
Transistor Socket,TO3	1	1	RTC-300T
Transistor Socket,TO66	1	1	TRC-400T
Pin	1	1	3/u 3/4"
Set Screw .15	12	12	8/32
Cable,Coaxial	10'	10'	RG/174
Filter	1	1	C3330
Filter	1	1	C3140
Indicators	2	10	#44
Indicators	2	10	#47
Transformer	1	1	3215

www.manualsplus.com
1011098